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WEEKLY 1 March 2025

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Online event

Measuring the mind

Join biologist and neuroscientist Suzana Herculano-Houzel on an exploration of how the human brain became the marvel that it is without ever breaking the rules of evolution. Find out how her revolutionary method of counting neurons allows us to compare brains across species. This subscriber-only online event will take place on 1 April at 6pm BST/1pm EDT.

newscientist.com/events

Tour

Whale watching in the Azores: Portugal

Explore the lush flora and fauna, volcanic craters, lagoons and picturesque towns of the Azores. Over 20 species of whales and dolphins, including sperm whales, blue whales, and bottlenose dolphins, visit this migratory crossroads. Learn about marine ecosystems, conservation efforts and animal intelligence on this seven-day tour, which starts on 13 May 2025 and costs £3499. Dates are also available in May 2027.

newscientist.com/tours

Podcast

Weekly

The team discuss the creation of a mini human brain in the lab, explore the potential of wood to replace many of the unsustainable materials we currently rely on, and marvel at a mouse that seems to be performing resuscitation on another mouse. Plus, find out the latest Earth-impact odds for asteroid 2024 YR4.

newscientist.com/nspod

ALMUDENA ROMERO/SAATCHI GALLERY

Flowers exhibition Iridescent cellulose reveals inner plant worlds

GEORGE KARBUS PHOTOGRAPHY/CONNECT IMAGES/ALAMY

Social creatures Uncover the secrets of dolphin communication

Video

Plants are artists

The latest exhibition at London's Saatchi Gallery explores the enduring presence of plants in art and culture. Beyond their beauty, flowers symbolise emotions, myths and stories, shaping our cultural language. The artworks on display acknowledge the innate features of plants, using their natural properties so that they become collaborators in the creative process.

youtube.com/newscientist

Newsletter

The Earth Edition

Environment reporter Madeleine Cuff brings you a roundup of the month's top nature and environment stories. Hear the truth behind "net-zero oil" and the latest on how the Trump administration is silencing US government climate scientists. Also, discover why rewilding may sometimes harm biodiversity.

newscientist.com/the-earth-edition

Podcast

"The mouse steps up its efforts and attempts to revive its unconscious companion"

Essential guide

These in-depth guides, brought to you by the team behind *New Scientist*, offer a comprehensive overview of pressing topics, including: the human mind, space exploration, nutrition and diet, exercise and artificial intelligence. Plus, receive a free slip case to store them when you buy any five.

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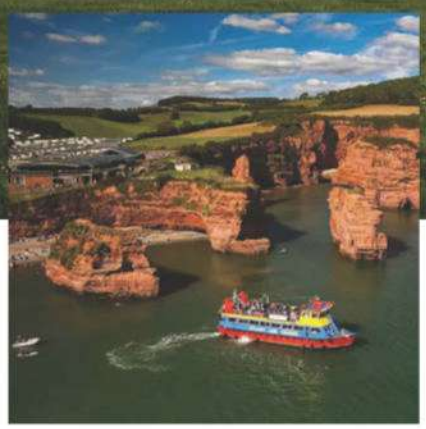

The science of the Jurassic Coast: Dorset and Devon

16 May 2025 | 3 days

Explore the science of the iconic Jurassic Coast, from its ever-changing landscapes to the future of its beaches, with insights from geologists, palaeontologists and conservationists. Here, 185 million years of Earth's history are laid out within the striking cliffs, offering an exceptional opportunity to study fossils and rock formations.

- **Enjoy insightful talks from a range of experts covering topics including human history, palaeoart, vertebrate evolutionary history and geological formations.**
- **Hunt for fossils along Lyme Regis's famed ammonite pavement accompanied by experts from the Jurassic Coast Trust.**
- **See the Jurassic Coast from a unique vantage point on a scenic cruise.**

Mysteries of the universe: Cheshire

27 June 2025 | 3 days

Spend a captivating weekend delving into the mysteries of the universe with an exciting programme that includes a special excursion to Jodrell Bank, home to the iconic Lovell Telescope. Engage with leading astronomers, astrophysicists and cosmologists as they illuminate the latest discoveries in space science, covering topics from galaxy formations to groundbreaking research on black holes.

- **Enjoy a series of fascinating lectures that will cover topics from the big bang through to the James Webb Space Telescope.**
- **See images of the southern hemisphere's skies through a remote astronomy demonstration that connects with a telescope in Australia.**
- **Stay in a delightful 4-star hotel in the Cheshire countryside.**

Human origins in the prehistoric south-west

14 July 2025 | 5 days

Immerse yourself in the early human periods of the Neolithic, Bronze Age and Iron Age on a gentle walking tour exploring the prehistoric sites of Wiltshire and Dorset. From complex Iron Age hillforts and ancient stone circles to some of the area's most beautiful landscapes, discover this quaint region of south-west England.

- **Visit several prehistoric sites, including the UNESCO World Heritage sites of Stonehenge and Avebury.**
- **During this tour, you will be joined in Cerne Abbas by *New Scientist*'s former editor-in-chief Emily H. Wilson, who will lead a guided walk around this prehistoric landscape.**
- **Visits to National Trust, English Heritage and UNESCO-listed sites, including Old Sarum and Maiden Castle, with a special behind-the-scenes tour of the Wiltshire and Salisbury Museums.**

Find out more at
newscientist.com/tours

Could you, should you?

Fictional scenarios can help us make decisions about real-life research conundrums

JEFF GOLDBLUM has made many contributions to this world, but perhaps the best is his delivery of an iconic line in the 1993 film *Jurassic Park*. During a scene in which his character, Ian Malcolm, berates the dinosaur park's creator, John Hammond, Goldblum utters the words that have become a long-enduring meme: "Your scientists were so preoccupied with whether or not they could that they didn't stop to think if they should."

The could-should paradigm, as we might loftily call it, is an excellent way to think about the risks and rewards of scientific endeavours.

Still, it is rare to see scientists strongly come out against their own area of research – Malcolm, as a mathematician, probably didn't much care about genetics developments. Perhaps this is what made recent warnings against creating "mirror life" – organisms in which molecules have the opposite orientation to everything else on Earth, with the potential to wreak havoc through the biosphere – so stark, coming as they did from people working directly on the idea (see page 34).

"The creation of mirror life has the potential to wreak havoc through the biosphere"

While mirror life fails hard on the "should" side of the scale – there seems to be little obvious reason for creating it – in other cases, the decision isn't so easy. Perhaps the thorniest recent example is gain-of-function research. This is where organisms, often pathogens, are modified to enhance their abilities, with both risks and rewards. Altering a flu virus, say, so that it can more easily infect humans, is clearly a risk. But if it helps us understand the virus and potentially prevent a pandemic, would it be worth it?

Gain-of-function has always been contentious, but, recently, the debate around it has become explosive. People who believe that SARS-CoV-2, the virus behind covid-19, was created in a lab – a belief for which there is no evidence, it should be said – have leapt on gain-of-function research as a smoking gun. Does this mean such work must be banned? Probably not – but, per Malcolm's words, we must bear in mind the distinction between "could" and "should". ▮

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Speaking multiple languages does seem to delay dementia p10

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We may soon see a gigantic star go supernova p14

Dastardly disguise
Cuttlefish transform into coral when hunting prey p14

AI vs AI
AI-generated optical illusions can sort bots from humans p15

Environment

Capybaras get a slimy new coat

It may look like these capybaras (*Hydrochoerus hydrochaeris*) are sitting in a swirl of green paint, but it's actually a slick of potentially harmful cyanobacteria on the surface of the Salto Grande lake. This artificial lake formed following the damming of the Uruguay river on the border of Uruguay and Argentina. Cyanobacteria blooms occur each year when both water temperatures and nutrient levels are high.

JUAN MABROMATA/AFP VIA GETTY IMAGES

Health

US stops sharing flu data with WHO

Uncertainty remains about whether the US will attend a key meeting to work out the composition of the next flu vaccine, which could affect its efficacy, finds **Grace Wade**

ALTHOUGH the US declared its intention to leave the World Health Organization (WHO) on 20 January, the process formally takes one year. Yet US health agencies have already retreated from nearly all coordinated global health efforts around influenza surveillance. The move could jeopardise the efficacy of the next batch of flu vaccines, both for the US and the rest of the world.

This comes as the US is in the midst of its most severe flu season in 15 years. At least 29 million people in the country have caught the illness since October and roughly 16,000 have died from it – and the season is far from over.

Numerous factors are probably behind the surge, including lower vaccination rates, says Erin Sorrell at Johns Hopkins University in Maryland. While adult flu vaccination rates are nearly the same as they were this time last year – about 45 per cent of US adults had had the shot as of 8 February – childhood vaccination rates have dipped. In early February 2024, nearly 51 per cent of adolescents were inoculated against seasonal influenza. Now, only 46 per cent are.

> **"We are not only putting the world at a disadvantage, but also the average American"**

The efficacy of this season's shot may also be to blame, though it is too early to say for certain. The two predominant influenza strains circulating in the US are the same ones that dominated the southern hemisphere's flu season, which ran from April to September 2024. Data from five South American countries suggests the vaccine reduced people's risk of hospitalisation for influenza by about 35 per cent, which is at the lower end of the typical efficacy range. If a similar rate is seen in the northern hemisphere, it suggests the shot was a weak match.

All of this shows the importance of a WHO meeting on 28 February, bringing together influenza experts from around the world to select which strains the next flu shot will target. This decision is based on influenza samples collected from 151 national laboratories across 127 countries. These will then be analysed at seven WHO collaborating centres to study how the virus spreads, evolves and interacts with vaccines and other treatments.

These collaborating centres, two of which are based in the US, play a major role in global influenza surveillance and response preparedness, says Maria Van Kerkhove at the WHO. The trouble is, the US centres stopped communicating with the WHO on 24 January, mere days after US president Donald Trump took office and ordered the withdrawal from the WHO. "We are communicating with them, but we haven't heard anything back," says Van Kerkhove.

RICHARD JULLIART/ALAMY

The US announced it was leaving the WHO on 20 January

This means the US has stopped sharing influenza data with the WHO and participating in crucial meetings on preparedness. As *New Scientist* went to press, it seemed highly unlikely that US representatives would partake in the 28 February meeting – a massive loss given the US Centers for Disease Control and Prevention (CDC) is the largest global resource for the control of pandemic and seasonal influenza, says Sorrell.

The WHO is currently working with other collaborating centres to fill the information gap left by the US, says Van Kerkhove. The halt in US communication shouldn't affect the WHO's ability to develop an effective flu vaccine for next season, she says. But it will certainly make it more challenging to do so in the future.

It will also have ramifications for US public health. "We don't get to provide our input on strains that we are most concerned about in the US and discuss mutations that we are observing here. Our technical experts, who are some of the best in the world, are not able to contribute to that conversation," says Sorrell. "So, we are not only putting the world at a disadvantage, but absolutely the average American, who would be looking to be vaccinated next year against seasonal flu."

Overall, it is unclear whether the US will have an input into the development of influenza shots in the future. The CDC didn't respond to a request for comment. A spokesperson for Sanofi – the largest flu vaccine manufacturer in the world – said it will continue to play a role in providing influenza protection both inside and outside the US, and that it "will be ready to support final strain selections in time for the season". It declined to answer whether final strain selection will take place with individual countries, such as the US, in addition to the WHO.

"We have no guarantees about what the next flu season will be like," says Sorrell. "We're essentially putting blinders on to be able to respond effectively." ▮

TESS CROWLEY/CHICAGO TRIBUNE/GETTY IMAGES

About 45 per cent of US adults had had the flu shot as of 8 February

Space

Asteroid 2024 YR4 will now almost certainly miss Earth in 2032

Alex Wilkins

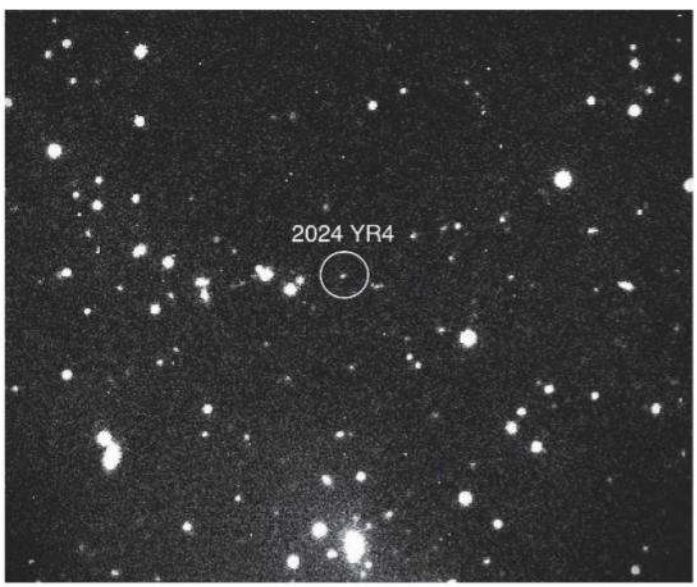
THE world's space agencies have reduced the chances of asteroid 2024 YR4 impacting Earth to well below 1 per cent, which strongly suggests that a potentially devastating collision will be avoided. However, the asteroid will probably still travel extraordinarily close to our planet, giving astronomers a rare opportunity to observe an asteroid up close.

"This is still something that will make a spectacularly close approach"

"We are not expecting the impact probability to rise back above 1 per cent for the close approach with Earth in 2032," says Richard Moissl at the European Space Agency (ESA). "The most likely further development is a further drop in the impact probability, likely even to 0."

Alarms about asteroid 2024 YR4 were first raised in December, when astronomers found it might be on a collision course with Earth in 2032. It appears to be between 40 and 90 metres wide and could generate a deadly blast should it hit a city. In the following weeks, the world's telescopes and space agencies closely tracked its trajectory, honing its future path with greater precision. It reached its highest impact risk on 17 February, with a 1-in-32 chance, but in the days afterwards, this fell to 1-in-67, or a 1.5 per cent risk.

New observations have led to a sharp downgrade of this risk and, on 24 February, NASA put it at a 0.0039 per cent chance of impact, or 1-in-25,641. ESA has it even lower, at 0.002 per cent, or 1-in-50,000. These ratings put it at a 0 on the 10-point Torino scale used to assess the hazard posed by such objects. That score is down from 3, meaning 2024 YR4 is now considered one of many low-risk asteroids that are discovered each year, but ultimately miss Earth.



NASA/MAGDALENA RIDGE 2-4M TELESCOPE/NEW MEXICO INSTITUTE OF TECHNOLOGY/RYAN

Alarms about asteroid 2024 YR4, circled, were first raised in December

This is good news, says Gareth Collins at Imperial College London, but the asteroid will still be useful as a dry run for our planetary defence systems and for scientific purposes. "This is still something that will make a spectacularly close approach. If the risk of hitting was as high as it was, it must be coming very close to us," he says.

NASA, ESA and space companies that were sketching out possible schemes to deflect the asteroid will probably continue planning, says Niklas Voigt at OHB, a German space company. Voigt and his team had begun thinking about a mission to divert 2024 YR4 and the new risk level doesn't change that, he says. "The risk decreased, but, for the time being, we are still proceeding with work on the topic."

The close approach could still be a good opportunity to test our ability to deflect asteroids, says Voigt. The only previous attempt to do this was NASA's DART mission, which successfully changed the trajectory of the 160-metre-wide asteroid Dimorphos in 2022. Or we could build a satellite to send to 2024 YR4, he says, similar to ESA's Ramses spacecraft. This is due to travel to observe the asteroid Apophis, which is set to pass close to Earth in 2029.

Moon target

The final decision on tackling 2024 YR4 probably won't be made until planned observations in March using the James Webb Space Telescope. As well as gathering trajectory data, this will better assess the size and composition of the asteroid. That information will then be fed to the United Nations-backed Space Mission Planning Advisory Group, which will decide on the best course of action around the end of April.

"These are incredibly useful exercises for finding out the pinch points to make decisions, in order to still have time to do something sensible in advance," says Collins. "Absolutely, those committees will still be meeting, but they'll probably be less stressful."

While the chances of an Earth impact have plummeted, the risk of 2024 YR4 hitting the moon have risen to 1.7 per cent, up from 0.3 per cent. There is a "distinct possibility of that number rising further", says Moissl. "The exact effects for an impact on the moon from an object of this size are still under evaluation."

The response to this object has also been a useful rehearsal for other asteroids of concern that crop up, says Collins. "We want to avoid, in future, a 'cry wolf' situation where the public gets so used to this threat that they think, 'Oh, it never happens'." ▮

40–90m
Estimated width of asteroid 2024 YR4

0.002%
Risk of asteroid 2024 YR4 hitting Earth in 2032, according to the European Space Agency

1.7%
Risk of asteroid 2024 YR4 hitting the moon in 2032

Analysis Health

Why being bilingual really does seem to delay dementia

Multiple studies suggest that speaking more than one language pushes back the onset of dementia, but doesn't seem to stop it entirely, finds **Helen Thomson**

LEARNING another language may stave off Alzheimer's and other types of dementia – and it's never too late to start.

Bilingualism was first linked to the deferral of dementia in 2007, when Ellen Bialystok at York University in Toronto and her colleagues examined the records of people who had been referred to a memory clinic and diagnosed with dementia. Of the 184 people in their analysis, symptoms appeared four years later in those who were bilingual than in their monolingual peers.

Further studies replicated these findings, but some scientists questioned whether bilingualism was merely a proxy for other lifestyle factors, such as having more money. "The confounding factors make the literature messy," says Natalie Phillips at McGill University in Montreal.

Researchers have since found a way through the mess. In 2013, Suvarna Alladi at the National

"Bilingualism changes the way you cope with an increasingly compromised brain"

Institute for Mental Health and Neurosciences in Bangalore, India, and her colleagues showed that bilingual people developed dementia 5.4 years later than monolingual individuals, regardless of their education, occupation, sex or immigration status. "What is emerging consistently," says Phillips, "is that older adults who speak more than one language have clear advantages against dementia."

The answer as to why is still incomplete, in part because there are so many ways people can use a second language. For instance, they may speak it with only one person or for just a few years or

CHRIS HOWES/WILD PLACES PHOTOGRAPHY/ALAMY

The ability to read many languages helps your brain, as well as your holiday

decades. However, recent imaging studies have given us a clearer idea of what's going on.

It comes down to brain resilience, says Phillips, which bilingualism seems to help in three ways. First, it boosts your brain reserve, or its size. If you assume that cognitive deficits associated with dementia occur at a fixed threshold of damage, a person with a greater brain reserve can sustain more damage before reaching that threshold. Those who are bilingual have more neurons in brain areas linked with language and increased volume in learning and emotion regions.

Being bilingual also benefits your cognitive reserve – the efficiency and adaptability of your brain. Someone with a high cognitive reserve can use different pathways to access the same information in the face of brain atrophy. "If you think of brain reserve versus cognitive reserve, it's like comparing a hardware advantage with a software advantage," says Phillips.

Bilingualism is thought to boost cognitive reserve in part because of the competition between languages in the brain: when someone who speaks English and French hears "for", their brain activates pathways for related words in both languages. This constant switching and inhibiting of pathways strengthens aspects of cognitive reserve known as executive functions – a suite of abilities that include decision-making, planning and attention.

Cognitive reserve

Supporting this idea, bilingual people can actually show greater atrophy in brain areas affected by Alzheimer's disease than those who are monolingual, despite no difference in cognitive function, which suggests that their cognitive reserve is higher to begin with.

Finally, we have brain maintenance, which refers to biological processes that keep your brain healthy when faced with pathological effects. Last September, Phillips's team showed a link between bilingualism and brain maintenance by studying bilingual and monolingual people who had early- or late-stage Alzheimer's, as well as individuals who felt like their memory was getting worse but who had no objective evidence of dementia.

The team found differences in the hippocampus, with bilingual people showing less decline in this region as cognitive problems progressed. "I found this tremendously interesting because the hippocampus is not a language centre; it is the primary memory centre," says Bialystok.

But there was no difference in hippocampal volume between monolingual and bilingual participants without signs of disease, which suggests that knowing two languages helps maintain the hippocampus when damage occurs, rather than increasing its size beforehand.

"What this all says is that bilingualism changes the way you cope with an increasingly compromised brain," says Bialystok. "It doesn't prevent dementia, it holds back the flood. When bilingual people eventually show cognitive problems, they decline faster, but it starts later. Imagine what families could do with that extra time."

Proficiency with a second language is associated with the protection offered, but "learning another language during adulthood [still] provides benefits to brain health," says Viorica Marian at Northwestern University in Illinois.

Nevertheless, the longer you can speak the second language for, the better, says Bialystok. "What you're doing is giving your brain tremendous stimulation, and the bottom line is what's hard for your brain is good for your brain." ▮

Zoology

Mice seen giving ‘first aid’ to other, unconscious mice

Chris Simms

WHEN they find another mouse unconscious, some mice seem to try to revive them by pawing at them and even pulling their tongue aside to clear the airway.

There are rare reports of large, social mammals trying to help incapacitated members of their species, such as dolphins attempting to push a distressed pod mate to the surface. Now, Li Zhang at the University of Southern California and his colleagues have filmed what happened when they presented laboratory mice with a familiar cage mate that was either active or anaesthetised.

Over a series of tests, the mice devoted about 47 per cent of a 13-minute observation window to interacting with their unconscious partner, on average, and they behaved in three ways. “They start with sniffing, and then grooming, and then with a very intensive or physical interaction,” says Zhang. “They really open the mouth of this animal and pull out its tongue.”

These more physical interactions also involved licking the eyes and biting the mouth area. After focusing on the mouth, the mice pulled on the tongue of their partner in more than 50 per cent of cases.

In a separate test, researchers gently placed a non-toxic plastic ball in the mouth of the unconscious mouse. In 80 per cent of cases, the helping mice successfully removed the object.

Mice that were attended to woke up and started walking again faster than uncared for mice. Once their charge had responded by moving, the carer mice slowed and then stopped their caregiving behaviour (*Science*, doi.org/n7tg).

The recuperative behaviour isn’t an analogue of CPR, which requires specialist training, says Zhang. It is more like performing basic first aid to ensure an unconscious person can breathe.

Similar behaviour is reported in lab mice in an accompanying research paper by another team and was also described by a third team last month.

Seeing this behaviour in wild mice might be hard as they usually hide from humans, says Cristina Márquez at the Center for Neuroscience and Cell Biology in Coimbra, Portugal. “But [the fact] that we don’t see it does not mean that they don’t do it.” ▮

A mouse tends to an unconscious peer by pulling its tongue

WENJIAN SUN ET AL. 2025

Environment

No mention of climate change in NOAA briefing

James Dinneen

THE US National Oceanic and Atmospheric Administration (NOAA) presents a briefing on the global climate each month – and in the first of these calls under the Trump administration, NOAA researchers avoided making any link between January’s record-high global temperatures and climate change caused by human greenhouse gas emissions.

“It’s not great for science. It’s not great for truth,” says David Ho at the University of Hawai’i at Manoa. Greenhouse gas emissions from humans have unequivocally played a role in raising global average temperatures.

“They avoided making any link between January’s record-high temperatures and climate change”

The latest briefing included reports that global temperatures in January were 1.33°C above the 20th-century average. This makes it the hottest January on record, coming on the heels of the hottest year on record. Each of the past 10 years is one of the 10 hottest years on record.

The government researchers also explained that these high temperatures in January came despite the cooling influence of a La Niña pattern in the Pacific Ocean, as well as unusually cool temperatures across much of the US. Other notable events mentioned included below average sea ice in both the Arctic and Antarctic.

However, the researchers didn’t mention global warming due to human greenhouse gas emissions and whether this played any role in these record-high temperatures, even in reply to direct questions.

In response to a question from *New Scientist* regarding the main drivers for the high global average temperatures, Russell Vose, head of the monitoring and assessment branch at NOAA’s National Centers for Environmental Information, said: “We don’t tend to put out an explanation for why a specific month was warmer or colder than normal at a global scale.”

However, in previous climate update calls, NOAA researchers have freely discussed potential drivers of unusual temperatures, including referencing background warming from human-caused climate change.

Vose did offer a potential explanation for the broader trend in high temperatures in recent years. “The warmth that we saw last year and in more recent years was probably tied to reductions in air pollution over the ocean,” he said.

He also mentioned a reduction in cloud cover. Both have been linked with a spike in the pace of warming seen since 2023, but numerous reports have found the overall rise in temperatures can only be explained on top of background warming due to rising levels of greenhouse gases.

When *New Scientist* asked explicitly if human-caused climate change played any role in the record high temperatures, the NOAA press representative abruptly ended the call, saying: “I’m not seeing any more on-topic questions from the media.”

The NOAA press office didn’t respond to a request for comment.

NOAA has faced scrutiny from the Trump administration for its role in sharing information about climate change. References to “global warming” and “climate change,” for instance, have been removed from thousands of government web pages in the wake of orders from Trump to roll back climate action. ▮

Neuroscience

Mini-brains have been fused to resemble that of a 40-day-old fetus

Michael Le Page

HUMAN "mini-brains" that contain 80 per cent of the cell types in a 40-day-old fetal brain have been created by fusing different organoids together.

"We're getting to the point that we are getting closer to the fetal brain," says Annie Kathuria at Johns Hopkins University in Maryland. The reason for doing this is to create organoids that are better suited for studying conditions such as autism and schizophrenia, which is hard to do in animals, she says.

"If we want to do disease, toxicology or environmental studies on a brain in a dish, we should get it as close as possible to the [human] brain," says Kathuria.

These structures are still nowhere near a real human brain, says Kathuria. "We're very far away from getting to the point where we have to worry that this is developing consciousness or pain or intelligence," she says.

In the past two decades, it has become possible to grow miniature versions of many human organs by putting stem cells in the right chemical and physical conditions. Both animal and human brain organoids are now widely used for research.

"We're very far away from the point where we have to worry that this is developing consciousness"

However, in addition to containing far fewer neurons overall, brain organoids are also made up of only a small fraction of the cell types found in a normal brain, making them more like miniature versions of specific brain regions than the entire organ. They also never grow more than a few millimetres wide because, with no blood vessels to supply oxygen, the cells in the middle start dying once they grow larger.

Kathuria's team is one of several that is trying to solve these issues by fusing different organoids together. The researchers generated two kinds of brain organoids from cerebral and hindbrain cells, plus an epithelial organoid, as these cells form blood vessels, among other things.

After 20 days, the three organoids – each less than a millimetre across – were brought into contact, resulting in fusion. Some cells moved from one organoid into another, so they intermingled to some extent (bioRxiv, doi.org/n7ph).

The team repeated the experiments with stem cells from three individuals, but each fused organoid was derived from a single person's cells.

Fusing organoid types in this way is certainly an exciting approach, says Madeline Lancaster at the MRC Laboratory of Molecular Biology in Cambridge, UK. But other teams have created fused organoids – sometimes called assembloids – with a similar level of sophistication, she says.

In addition to creating most of the cell types seen in early fetal brains, the team also saw the early stages of epithelial cells sprouting into blood vessels, says Kathuria.

So far, no group has managed to create brain organoids with working blood vessels, says Lancaster.

At some point, the scientific community will have to decide on a cut-off point beyond which further development of brain organoids is unethical, says Kathuria. ▮

Climate change

Glaciers have shrunk by more than 5 per cent since 2000

THE rate of melting for glaciers has accelerated by more than a third in the past decade and, since 2000, they have shrunk by more than 5 per cent on average.

"Any degree of warming matters for glaciers," says Noel Gourmelen at the University of Edinburgh, UK. "They are a barometer for climate change."

The new numbers come from a global consortium of hundreds of researchers called the Glacier Mass Balance Intercomparison Exercise. The group aimed to reduce the uncertainty around how much the planet's 200,000 or so glaciers have melted by using a standard procedure to assess different measures of their change in size.

FABRICE COFFRINI/AFP VIA GETTY IMAGES

The Rhône glacier in the Swiss Alps, seen here in 2024, used to fill the valley

Between 2000 and 2011, glaciers melted at a rate of about 231 billion tonnes of ice per year on average. This rose between 2012 and 2023 to 314 billion tonnes per year, an acceleration of more than a third. 2023 saw a record loss of around 548 billion tonnes (*Nature*, doi.org/n7pm).

These numbers are in line with previous estimates. But this study "provides a bit more confidence about the change that we see on glaciers", says Gourmelen, who is part of the consortium. "And there's a clear acceleration."

The thawing of around 7 trillion tonnes of glacial ice since 2000 has raised sea levels by almost 2 centimetres, making it the second-biggest contributor to sea-level rise so far, after the expansion of water due to warming oceans.

"This is a consistent story of glacial change," says Tyler Sutterley at the University of Washington in Seattle. "Regions that have had glaciers since time immemorial are losing these icons of ice."

Depending on future emissions, the world's glaciers are projected to lose between a quarter and half of their ice by the end of the century. ▮

James Dinneen

The bold plan to release Tasmanian devils on mainland Australia

Rewilding advocates believe the predators could suppress non-native feral cats and foxes across the continent, finds **James Woodford**

I'M SHARING a ride with two very cranky and confused Tasmanian devils, loaded in the back of our vehicle inside large plastic traps. These devils are a long way from their species' home on the island of Tasmania. Instead, we are bumping along inside a wild but securely fenced 400-hectare sanctuary in Barrington Tops, 4 hours north of Sydney.

Tasmanian devils (*Sarcophilus harrisii*) did live on the Australian mainland once upon a time, but it is thought that they disappeared from here around 3000 years ago, probably because of the arrival of Australia's native dog, the dingo (*Canis lupus dingo*), along with pressure from humans and climate change. Dingoes didn't make it to Tasmania, and so the devils survived there.

Now, however, throughout much of south-eastern Australia, the dingo is also mostly gone, hunted and baited because it is a pest to farmers. Consequently, non-native feral cats and foxes have torn through native fauna, leading to a cascade of extinctions and endangered populations.

As our vehicles crawl along, snaking between giant, ancient trees, something extraordinary happens. From out of the bracken, a Tasmanian devil, the size of a small dog, lopes out in front of us. For a few seconds it scampers along the track, and then it vanishes back into the vegetation.

To see Australia's largest marsupial carnivore roaming where it hasn't been for millennia is an extremely disorienting moment. But if Aussie Ark's Tim Faulkner, who is driving me through the forest, has his way, this will be a scene replicated across the nation. By the end of 2026, he and his team want to see Tasmanian devils being released outside of the sanctuary's fences.

JAMES WOODFORD

Tim Faulkner at Aussie Ark gets ready to release a Tasmanian devil into a fenced sanctuary

After which, he says, they will need to be renamed. "I believe the devil is the Australian devil," he says.

We soon reach an old-growth eucalyptus forest and Faulkner parks up where our precious cargo is being released. The first devil doesn't need much encouragement and, after sliding out of its trap, it trots off, only to circle back a minute later.

> **"Reintroducing Tasmanian devils could prevent the death spiral of biodiversity in Australian ecosystems"**

The second resists coming out of its trap and then sits frozen on the ground for several minutes after being tipped out. Eventually, it too disappears into the forest.

The devils were brought to Barrington as an insurance population because their numbers have plummeted in Tasmania from an estimated 53,000 in the mid-1990s to 17,000 by 2021, after the species was ravaged by devil facial tumour disease, a contagious form of cancer.

Since 2010, 500 devil joeys have been born at Aussie Ark in Barrington. Around 50 have been released into the fenced sanctuary, and at any time there are around 200 devils in the complex.

Getting these animals out from behind fences would help restore balance to the ecosystem by keeping other predators under control, says Faulkner, preventing the death spiral of biodiversity in Australian ecosystems.

"Tasmanian devils are a natural control solution for foxes and cats and they do that because foxes and cats den their joeys [young], and the devils can go down there into the dens and eat them," says Faulkner. "Predators don't really like predators, so [the adults] avoid each other."

After the release of the two males into the sanctuary, I witness first-hand why he thinks devils could give feral foxes and cats a run for their money. A kangaroo leg has been fed to around half a dozen devils in a breeding area of the complex, and it is one of the most gruesome displays of carnivory and gore imaginable.

It is no exaggeration to say that if you closed your eyes and just listened to the devils feasting, it could easily be the soundtrack to a zombie movie. Pound for pound, they have among the strongest jaws in the animal kingdom and a bloodlust that doesn't belie their name.

Faulkner's plan to release devils into mainland ecosystems has some high-profile supporters, including Tim Flannery at the Australian Museum in Sydney. But what effect they would have on other predators remains to be seen. "I believe that the first, obvious step is to release devils into a fenced area that includes feral cats and foxes, and determine the impact," says Flannery. "Devils may consume young cats and foxes and compete for scavenge."

Menna Jones at the University of Tasmania says there is evidence that devils suppress feral cat numbers in Tasmania, but because foxes aren't present on the island, the effect on them is unknown.

"Reintroducing an extinct predator, whether it's been gone for 50 years or 3000 years, is a really big deal," says Jones. "You do not put a predator into an open landscape without a whole raft of considerations."

Space

Gigantic star may be about to explode

Chris Simms

ONE of the largest stars in the known universe is undergoing a strangely rapid transformation and may soon explode as a supernova.

WOH G64 sits some 160,000 light years from Earth in the Large Magellanic Cloud, a small satellite galaxy of the Milky Way. It is one of the biggest red supergiants, the largest stars we know of. These are massive, cool stars that have run out of hydrogen fuel in their core and instead burn an envelope of hydrogen gas that surrounds them.

The star was thought to be about 1500 times the size of the sun, but is pretty unstable, losing mass faster than any other known red supergiant. Now, using data from the Very Large Telescope and Magellan Telescopes in Chile, Alceste Bonanos at the National Observatory of Athens, Greece, and her colleagues have spotted a more dramatic shift.

"This transition seems to have happened over a few years – an astronomical blink of an eye"

By analysing the star's light, they found that it had gone from being about 3000°C with a strong signature of titanium oxide and a reddish colour, which is typical of a red supergiant, to heating up to about 4500°C and having a strong signature of elements such as iron and nickel and a bluer colour (Research Square, doi.org/n7nt).

The star had changed so much, says Bonanos, that "one of our co-authors said, 'Wait, did I observe the wrong star?'" But it was the right one, she says. "That was the first clue that something was going on."

Exactly when this transition occurred is unclear, given a lack of continuous observations, but it seems to have happened over just a few years – a blink of an eye in astronomical terms.

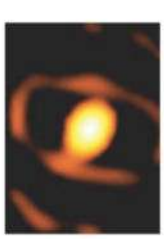
The researchers suspect that a few things are going on. First, that WOH G64 turned from a red supergiant into a quieter yellow hypergiant. Such a transformation has previously been hypothesised, but we have never seen it happen.

Second, the researchers think that the outer layers of the star have been stripped away. This may have happened, they say, because its stellar wind has ramped up, releasing huge amounts of gas and hinting it might soon explode as a supernova. Alternatively, the stripping may have been caused by interactions with another star, suggesting that WOH G64 is actually part of a binary system.

"We knew something was brewing and that what WOH G64 had been doing was unsustainable. It has been losing mass at such a rate," says Jacco van Loon at Keele University, UK, whose team revealed an image of the star last year. "But we didn't know it was going to happen in our lifetime."

But Roberta Humphreys at the University of Minnesota thinks something different has been happening. She suspects WOH G64 might have been a yellow hypergiant all along, but went through a period of intense activity during which it looked like a red supergiant and it has now reverted. Such behaviour has been seen in other stars, she says.

Bonanos and her team will observe the star over the next year to see what happens next. ▮



ESO/K. OHNAKA ET AL.

WOH G64 is a star in the Large Magellanic Cloud, a galaxy 160,000 light years from us

Marine biology

Cuttlefish disguise themselves as coral when hunting prey

Sofia Quaglia

UNIVERSITY OF BRISTOL

This cuttlefish mimics coral by splaying its arms and changing its colour

DAZZLING camouflage helps cuttlefish transform themselves into non-threatening objects while stalking their prey.

"These are masters, the hypnotists of the underwater world," says Matteo Santon at the University of Bristol, UK.

Cuttlefish can change their colour and texture in less than a second thanks to millions of pigment sacs in their skin called chromatophores. They can also create and control precise patterns on their bodies, such as moving stripes. When Santon travelled to Indonesia to study these kinds of abilities in broadclub cuttlefish (*Sepia latimanus*), he realised each individual could pull off different forms of camouflage, something he says is "very unusual".

He and his colleagues filmed 98 cuttlefish pursuing prey 234 times. On some hunts, the animals turned pale grey, extended an arm on each side and flashed a dark stripe repeatedly down their body. Some also splayed all eight arms out in front of their body and turned a mottled yellow and orange to resemble a branched coral. Others mimicked a leaf by turning shades of olive green, sticking out their arms in three directions and slowly floating up and down (*Ecology*, doi.org/n7ns).

Each technique probably has a different purpose, says Santon. His preliminary research suggests sliding stripes mask the cuttlefish's approach or create enough visual noise to bamboozle prey. The leaf and coral camouflages may be attempts to look like non-threatening objects.

These displays could allow cuttlefish to approach prey faster and avoid being spotted by their own predators, says Trevor Wardill at the University of Minnesota.

But it is unclear how cuttlefish decide which display to use and when. Their choices may depend on the environment or the type of prey they are hunting, or they might just use a random rotation of camouflage types.

Wardill's octopus research shows that their strategy for hunting varies according to prey. He says it is "quite possible" that cuttlefish are also choosing their camouflage technique based on the meal they are pursuing. ▮

Health

Record nerve cancer remission

Person who had neuroblastoma has been tumour-free for 18 years thanks to cell therapy

Carissa Wong

A CANCER therapy that uses genetically engineered immune cells, called CAR T-cells, has kept a person free of a potentially fatal nerve tumour for a record-breaking 18 years.

"This is, to my knowledge, the longest-lasting complete remission in a patient who received CAR T-cell therapy," says Karin Straathof at University College London, who wasn't involved in the treatment. "This patient is cured."

Doctors use CAR T-cell therapy to treat some kinds of blood cancer, like leukaemia. To do this, they collect a sample of T-cells, which form part of the immune system, from a patient's blood and genetically engineer them to target and kill cancer cells. They then infuse the modified cells back into the body. In 2022, a follow-up study found that this approach had put two people with leukaemia into remission for about 11 years, a record at the time.

But CAR T-cell therapy usually fails against solid tumours like neuroblastoma, which occurs when developing nerve cells in children turn cancerous, typically before age 5. Such tumours often strongly resist being attacked by the immune system, reducing the modified T-cells' effectiveness.

"This is the longest-lasting complete remission in a patient who received CAR T-cell therapy"

This is why Cliona Rooney at the Baylor College of Medicine in Houston, Texas, and her team were surprised to find that a person who had neuroblastoma during childhood – who they had treated with CAR T-cell therapy as part of a trial in 2005 – remained cancer-free more than 18 years later (*Nature Medicine*, doi.org/g85dhs). "These results were amazing – to get complete responses in neuroblastomas with this approach is quite unusual," says Rooney.

The person had received the treatment at age 4 after several rounds of chemotherapy and radiotherapy failed to fully eradicate their cancer. At the time, the team also treated 10 other people with the same condition whose cancer had also relapsed after standard treatment, and they all experienced virtually no side effects, says Rooney. One of these participants showed no signs of cancer nearly nine years later, before they dropped out of the study, making follow-up impossible. The remaining nine died due to their cancer, mostly within a few years of receiving the treatment.

It is unclear why some people responded so much better than others. "That's the million-dollar question, we really don't know why," says Rooney.

One reason could be that each individual's T-cells behave slightly differently depending on their genetics, prior infections and lifestyle factors such as diet, says Rooney. Indeed, the team found that CAR T-cells were more persistent in the blood of those who survived for longer.

Another explanation could be that some participants' tumours were more immunosuppressive and resisted the CAR T-cells more strongly, says Rooney.

Her team is now exploring new ways to engineer the cells so that they can benefit more people. "We have to improve them and make them more potent, without increasing toxicities," she says.

Such endeavours are likely to yield further success, says Straathof. "Now we've seen a glimpse of what is feasible." ▮

For more on the uses of CAR T-cells, turn to page 26

Technology

AI-generated optical illusions can sort humans from bots

ARTIFICIAL intelligence programs can create optical illusions that other AIs are unable to recognise, creating a useful test that can differentiate humans from bots.

A cat-and-mouse game has played out for almost two decades between website developers, who want to keep bots out of their sites, and the hackers who want to bypass those protections. Websites deploy CAPTCHA tests that are designed to be easy for humans to pass, but that trip up software. While these have become trickier to crack, the pace of AI development means that bots have quickly gained the ability to solve any new test.

Now, Yuekang Li at the University of New South Wales in Sydney, Australia, and his colleagues have developed a new test they call IllusionCAPTCHA. It uses generative models to create optical illusions that combine an input image and a prompt. For example, given a photograph of an apple and the prompt "sunny cityscape", the AI might create an image of a city in the shape of an apple.

For the test, subjects are shown these images and asked if they feature an illusory aspect, such as combined images or hidden text. When 10 people attempted the test, they passed 83 per cent of the time when illusionary text was added to an image, and 88 per cent of the time when illusory images were incorporated. But neither GPT nor Gemini, the two AI programs assessed, successfully passed any (arXiv, doi.org/n7nr).

ZIQI DING ET AL. (2025)

Is it an apple or a cityscape? A bot couldn't tell you

Li says the test relies on the unique way the human brain processes visual information. The gap between what AI and humans are capable of is of use to researchers looking to improve AI, he says. "We're trying to make AIs closer to human, closer and closer, and the more similar to humans they are, the harder it is for us to differentiate," says Li.

He expects AI to eventually become more capable than humans even at visual tests, which will force CAPTCHAs to look for things that AIs can do but humans cannot. However, AIs will then learn to pretend to be unable to do these tasks. "I think it's going to be a problem forever," he says. ▮

Matthew Sparkes

New Scientist

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Comment

Two legs bad?

A lot of technological effort is being poured into developing humanoid robots, but it is missing the point, says **Leah Crane**

SCIENCE fiction, from *The Jetsons* to the Marvel Cinematic Universe, is replete with humanoid robots. But for a long time in the real world, such robots have been a novelty at best and a punchline at worst. Somehow, though, in the last few years, things have shifted. More than a handful of companies are developing humanoid robots, and these technological simulacra have begun popping up in automobile factories and shipping outfits. Some firms are even promising household robots. Still, the most important question has yet to be satisfyingly answered: what is the point? Why make a robot shaped like a human, when it could be any shape at all?

The go-to response has always been that humanoid robots can, in theory, perform any physical task that a human can perform. But "in theory" is carrying an awful lot of weight there. If you have seen any video of a humanoid robot, you will know what I mean: as a whole, they are bumbling, stumbling machines. The tech required to allow them to stand and walk has vastly improved over the years, but they are still nowhere near as agile as most people.

Single-purpose robots, on the other hand, have become almost pedestrian. That's because, designed with one task in mind, they tend to do that task very well; think of a robot arm that moves a product from one conveyor belt to another. These robots have a clear scope of purpose, and they are fine-tuned to perform it, something impossible for a robot intended to be all-purpose, as most humanoid robots purportedly are.

ELAINE KNOX

The other reasoning often given to make a robot look like a person is that this makes it easier for humans to operate or interact with them. That explanation seems more plausible, especially given how many of these robots currently require highly trained human operators. The companies that make them tend to be cagey about this, claiming that it is temporary, but the idea that humanoid robots will be artificially intelligent – and, crucially, that the AI will allow them to operate as a human worker would, or better – is far from a foregone conclusion.

For now, what we have are human-shaped robots operated from behind the scenes by actual humans. When Elon Musk announced a new version of Tesla's Optimus robot in 2021, he said onstage: "It can be a teacher or babysit your kids. It can walk your dog, mow your lawn, get the groceries... serve drinks, whatever you can think of." But the robots at that event weren't powered by AI, as Musk and many others claim future ones will be. Each one was controlled by a person behind the scenes. You may notice that the jobs mentioned have something in common: they tend to be low-paid, and most are in customer service. If each robot requires its own human operator, which seems to be the case for now, this simply hides human labour behind a mechanical face.

There are situations where remote operation is helpful or necessary – bomb disposal or deep-sea exploration, for example – but those same situations seem to be ones where a human shape is manifestly not the optimal one. The limited-purpose robots built for those tasks are shaped like capsules with retractable arms, or little boxes trundling along on wheels, and humans manage to operate them just fine. The idea that a human shape is the best shape is a failure of imagination.

Yes, humanoid robots are flashy. They evoke our sci-fi dreams of a future of leisure, with all of life's tedious and dangerous tasks automated and all human needs met. But that is far from the world we are in. In this reality, they are little more than promotional tools, hiding all-too-human labour behind a veil of machinery. And a robot that doesn't improve the human condition is a robot that is missing the point. ▮

Leah Crane is a *New Scientist* features editor

No planet B

Big fight over little fish

Sand eels, small fry that feed a multitude of animals, including some of the UK's most iconic seabirds, are under threat from overfishing, writes **Graham Lawton**

Graham Lawton is a staff writer at *New Scientist* and author of *Mustn't Grumble: The surprising science of everyday ailments*. You can follow him @grahamlawton

Graham's week

What I'm reading
The Name of the Wind, *by Patrick Rothfuss. Part one of a classic fantasy trilogy,* The Kingkiller Chronicle.

What I'm watching
Season two of Severance *on Apple TV+. Worth the subscription alone.*

What I'm working on
Buying a new house.

This column appears monthly. Up next week: Annalee Newitz

LAST July I visited Bempton Cliffs, a nature reserve on the north-east coast of England managed by the Royal Society for the Protection of Birds.

Throughout the spring and summer, around half a million seabirds nest on the precipitous chalk cliffs, making a cacophonous riot that is one of the most spectacular sights in the nature-denuded UK. A significant proportion of the world's population of northern gannets breeds there, as do kittiwakes, guillemots, razorbills and – the star attraction – Atlantic puffins. Whales and dolphins can be seen offshore, though I was out of luck that day. All of these animals depend, to a lesser or greater extent, on sand eels, a collective term for several species of small marine fish. Puffins are especially reliant on them; one of the iconic sights of Bempton is a puffin with a row of the small, silvery fish dangling from its colourful beak.

But humans also catch sand eels. We don't eat them, but rather turn them into fertiliser and fishmeal for the aquaculture industry. North Sea stocks are overfished and, not coincidentally, seabird numbers there have also fallen. In UK waters, birds that eat sand eels have declined by 60 to 70 per cent in recent years, according to Charles Clover, co-founder and executive director of the conservation group Blue Marine Foundation and author of *Rewilding the Sea*. Puffins are now officially classed as globally vulnerable by the International Union for Conservation of Nature. They are also on the UK's Red List of species most in need of conservation. Kittiwakes are on both lists too.

Last year the UK government banned sand eel fishing in the English North Sea and all Scottish waters in response to scientific evidence that overfishing is a cause of declining seabird populations. The government's ability to do this is down to our departure from the EU's Common Fisheries Policy, one of the few tangible benefits of Brexit. But the Danish sand eel fleet, which holds about 96 per cent of the EU's quota, doesn't want to lose access to UK waters, which make up around half of its traditional fishing area. Dogger Bank in the North Sea – which is about halfway between Bempton and the west coast of Denmark – is especially important. It also happens to be where the Bempton puffins go to feed during their breeding season.

> **"It's a fight between niche capitalism and the public interest; it's one of the biggest of our time"**

Denmark challenged the ban under the terms of the post-Brexit trade deal between the UK and the EU, with the EU's backing. It is the first legal test of the Trade and Cooperation Agreement, which, among other things, sets out fishing rights. Attempts to resolve the issue amicably came to naught and the case found its way to the Permanent Court of Arbitration, an international dispute resolution body based in The Hague in the Netherlands. The court held hearings in January, at which Denmark and the EU reportedly challenged the scientific evidence underpinning the fishing ban. They also claimed the ban was "discriminatory" against Denmark because it has the largest sand eel fleet. The UK stands by the evidence and points out that the ban applies to all EU nations, so isn't discriminatory. The court is expected to rule in April. There is no path to appeal.

This might feel like a local, bureaucratic skirmish over a relatively trivial fishery, but the outcome could have significant ramifications for global marine conservation efforts.

I am not generally impressed by the UK's environmental record, but on marine conservation it is a trailblazer – one of only two countries in the world to have already achieved the global target of conserving 30 per cent of territorial waters by 2030. Admittedly, the vast majority of that surrounds remote British Overseas Territories such as Pitcairn and Ascension Island, but credit where it is due.

A UK loss could be dire. France has already claimed it has the right to bottom trawl in the UK's Marine Protected Areas (MPAs), presumably including those around overseas territories. These are out of bounds to industrial fishing; the ban generally holds because of draconian penalties for breaching it. But the court may also judge them to be in breach of the law. "If we lose the sand eel case we'll lose the offshore MPAs, our government is convinced of that," Clover told the recent Citizen Zoo 2025 Rewilding Conference in Cambridge, UK. "It's a fight between niche capitalism and the public interest; it's one of the biggest of our time," he said. On such tiny fish, rare and precious global conservation successes may flounder.

Just before Christmas, I went back to Bempton. The seabirds were mostly gone, away at their winter feeding grounds. It was cold and eerily quiet. The birds will be back in numbers this spring, but if the sand eel case goes the wrong way, for how much longer? ▮

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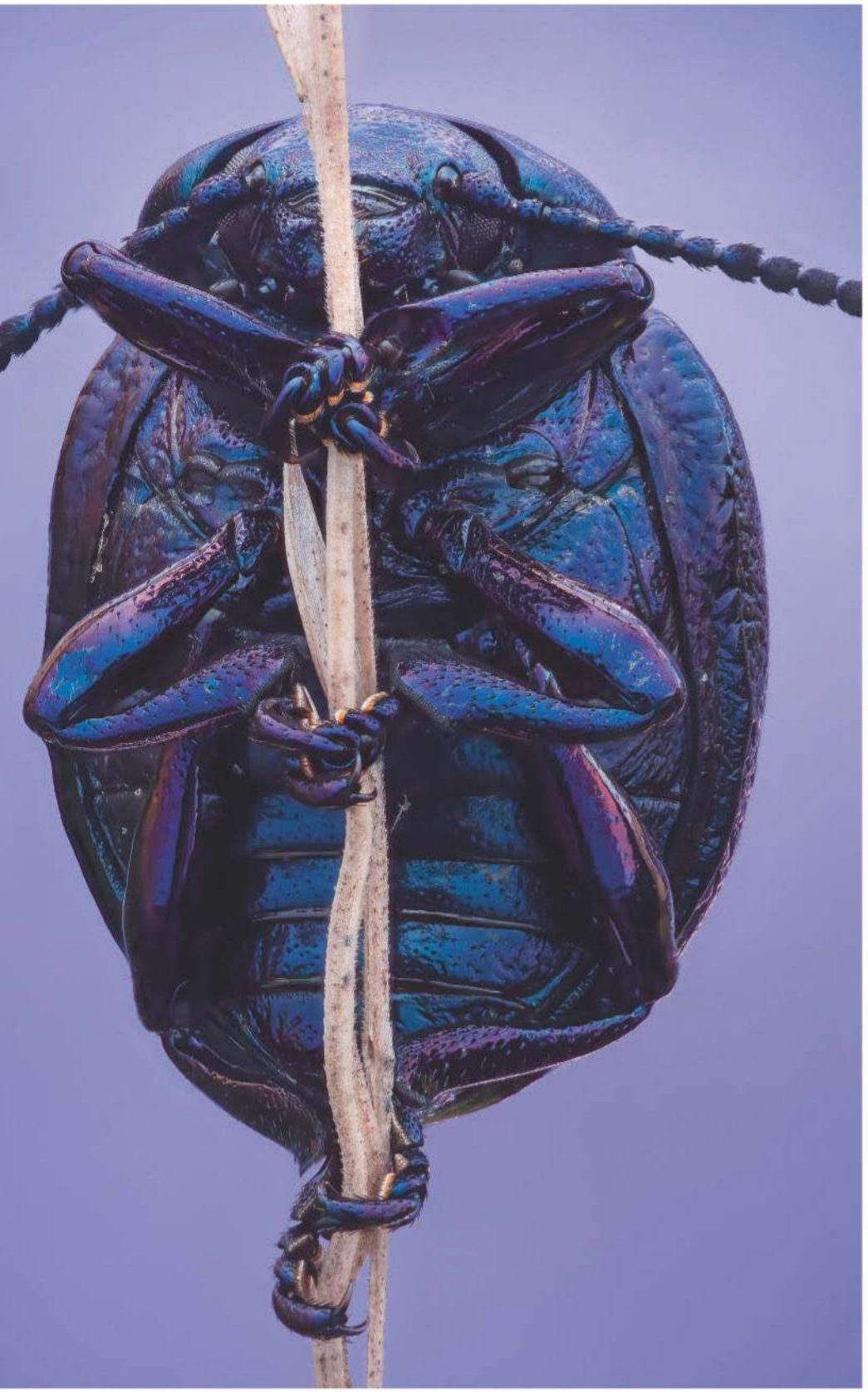

Micro marvels

Royal Entomological Society

DAMSELFLIES can't smile – but their wide-open mandibles make them appear to be grinning broadly or even sticking out their tongue, says Benjamin Salb, who photographed one of the insects, shown far left, at a pond in his local park in Gaithersburg, Maryland, last year.

It is among Salb's winning and commended entries in the Royal Entomological Society's 2024 Photography Competition. Another commended image is shown at near left. Captured by Tyler Redford, it shows a violet leaf beetle (*Chrysolina sturmi*) clinging to grass stalks. Redford had been searching for spiders, but was struck by the beetle's "insane" iridescent tones.

Taking eye-catching pictures of insects requires lots of patience, luck and muscle memory, says Salb. He aims to photograph them during warmer months in the pre-dawn hours, when they are less active. Multiple shots are taken at different focal lengths and then combined to increase the depth of field in the final product, which is often a result of dozens of images.

The picture of the damselfly – exact species unknown – is one of Salb's favourites because it features the insect's symmetrical pseudopupils: the dark ovals that appear on the compound eyes, which are made up of many lenses.

"I love photographing damselflies because they're capable and fierce predators with an almost cartoonish look when seen close-up," says Salb. "I find them to be good subjects to share with kids – and adults – to get them more interested in the small world around us."

Jeremy Hsu

Of flora and fauna

Palaeontologist Riley Black explores how animals and plants shaped each other over millions of years. **Simon Ings** is hooked

Book

When the Earth Was Green

Riley Black

St Martin's Press (US, available now; UK, later this month)

CHRISTIAN JEGOU/SCIENCE PHOTO LIBRARY

An artist's impression of an environment where prehistoric plants thrived

THE behaviour of plants is invisible to the naked human eye. They operate on timescales our imaginations can't entertain, and they run roughshod over familiar categories of self, other and community. I confess that I find them boring.

Luckily, others don't – Riley Black, a palaeontologist and an occasional *New Scientist* contributor, for one. Wandering among (or is it through?) a 14,000-year-old aspen clone, a single organism made up of thousands of stems, she wonders, how "many living things have alighted on, chewed up, dwelled within, pushed over, and otherwise had a brush with a tree so enduring it probably understands the nature of time better than I ever will"?

The above comes from her new book, *When the Earth Was Green: Plants, animals, and evolution's greatest romance*. It is a paean to plants in the form of a series of vignettes showing how they co-evolved with animals, each account separated from its neighbours by millions, tens of millions, sometimes hundreds of millions of years.

It isn't as immediately startling as Black's 2022 book, *The Last Days of the Dinosaurs*, which I described in these pages as "palaeontology written with the immediacy of natural history". It is a worthy successor, though.

Riley excels at conveying life's precarity. Life doesn't recover after extinction events, nor does it regenerate. It reinvents itself. Early on – 425 million years ago, to be exact – we find life flourishing in strange lands, under skies so short of oxygen, fires can only smoulder and dead plants can't decompose.

When oxygen levels rise, existing insect species grow gigantic in a desperate (and, ultimately, losing) battle to elude the toxic effects. After an asteroid brings the Cretaceous Period to a fiery end, 66 million years ago, we find surviving plant species innovating unexpected relationships with their remaining pollinators. Eventually, parts of the planet grew so verdant that some plant species could abandon photosynthesis entirely and simply parasitise their neighbours.

"Life doesn't recover after extinction events, nor does it regenerate. It reinvents itself"

Adaptation is a double-edged sword in such a changeable world. It allows you to take full advantage of today's ecosystems, but how will you cope with tomorrow's? As Black points out, staying unspecialised has allowed the ginkgo tree to survive catastrophe 66 million years ago and persist for millions and millions of years.

Black allows her imagination full rein. As she envisions wandering through a dense, humid, prehistoric forest where "millipedes grow more than six feet long and alligator-size amphibians silently watch the shoreline for unwary insects", it is easy to forget how rigorous and topical the underlying research is. (The millipede, *Arthropleura*, was discovered only three years ago.)

Her extensive endnotes do explain the limits of our current knowledge and the logic behind her rare fancies. These passages are integral and include some of Black's most insightful writing.

Above all, this is a book about how animals and plants shape each other. When animals large enough to knock over trees without even noticing disappeared, forests grew denser, with a continuous overstory that gave even the largest of creatures a third dimension to explore.

Those thick forests forced the surviving mammals and the few dinosaurs left into novel shapes and, even more importantly, novel behaviours. Both classes learned to spend more time with their young. And, if we are prepared to cherry-pick our mammalian examples, we can just about say that both learned to fly.

When the Earth Was Green may be too cutesy for some. The sight of a couple of sabre-toothed cats rolling about in a patch of catnip will either enchant you or it won't. Early on in the book, you may wince at the idea of a tree "understanding time". Perhaps all writers who engage with plants suffer this fate: the rhetorical tools they reach for date far faster than the science.

That said, this is an excellent work. I still think plants are boring, and would happily pulp the lot of them to make books as fascinating as this one. ▮

Simon Ings is a writer based in London

There's no end in sight

Despite real existential threats, a new book shows we are still too fascinated by the end of the world. **George Bass** explores

Book

A Brief History of the End of the F*cking World

Tom Phillips

Wildfire

IN 1950s Chicago, aliens from the planet Clarion made contact with Dorothy Martin. They warned her of a "holocaust of the coming events" that would begin on 21 December, 1954. Lake Michigan would subsume Chicago, and the rest of the world would follow into oblivion. Martin and her followers would be airlifted to safety on Clarion via flying saucers – but only if they first removed all metal fixtures from their clothing.

The fact that you are reading this at all confirms that the prophecy was inaccurate. But despite the frustration for Martin's followers – some of whom were undercover psychologists researching fundamentalism – she isn't the only layperson to receive such a vision.

Tom Phillips tells many such stories in *A Brief History of the End of the F*cking World*, detailing our fascination with the end times. This ranges from theological warnings by Zoroaster – an Iranian prophet who in about 1000 BC imagined a good-versus-evil final battle – to film directors and video game developers who variously feed our hunger for cataclysms. Hollywood director Roland Emmerich (*The Day After Tomorrow* and *2012*), he writes, "has killed more people than almost anyone else in history".

Phillips reprises the same genial tone as in his bestseller *Humans: A brief history of how we f*cked it all up*. It's a great read. He fills his timeline of unfulfilled apocalypses with wry humour and keeps the queue of plagues and judgements accessible. He jokes about unoriginal doomsday scenarios, reimagining, for example, the Four Horsemen of the Apocalypse as Death, Inflation, War and War Again.

He identifies the gear change in eschatology during the 19th century when art and science began to compete with religion, foretelling disasters that weren't just the work of a wrathful god. Phillips moves us through a calendar of judgement days including the return of Halley's Comet (whose tail of toxic cyanogen was hyped into headlines about doom in 1910) to current QAnon conspiracies.

Modern apocalypses are legion: something to be expected since, as he writes, "ours is the age of doomscrolling", with one British tabloid apparently publishing 87 killer asteroid stories in a single month. Imminent wipe-out, says Phillips, plays into online journalism's feedback loop.

So, which predictions were made in scientific earnest, and which belong in the gag reel? Among the less credible Armageddons is the case of the Triune Immersionists of Massachusetts, whose followers gave away their livelihoods in 1909 because they believed Earth's crust was about to peel off. Others have deeper roots, as people react to real predicaments. Take the significant spike in apocalyptic thinking following the Black Death (bubonic plague) in the 14th century.

Phillips also argues that two doomsday scenarios are playing out now. First, militant conspiracism, which he traces via the 1990s Ruby Ridge and Waco stand-offs in the US. Both conflicts saw federal agents face down cult groups with fatal consequences; both hinted at an extremism that today is more visible and arguably loaded with stronger rhetoric.

The other is climate change. Here, Phillips cites markers such as the shift of Vermont's thaw by a few days per decade, and Greenland's unsynchronised plant bloomings. This is no fantasy designed to fill an "apocalypse-shaped hole in our souls".

He warns that any future is best approached with rational analysis and a sharp eye for charlatans. As he writes: "The world is impermanent, but the grift is eternal."

George Bass is a writer based in Kent, UK

We may live in an age of doomscrolling, but we can keep wild, apocalyptic thinking at bay

STEPHEN TAYLOR/ALAMY

New Scientist *recommends*

Bethan Ackerley
Subeditor
London

I won't pretend to know much about opera, but was hooked by the radio show **Jennifer Walshe: Zero-gravity opera**, on the BBC World Service recently. It previews an as yet untitled work

by Walshe (pictured), a professor of composition at the University of Oxford. She is writing the opera with Mark O'Connell as librettist – he won the Wellcome Book Prize in 2018 for his exploration of transhumanism.

The opera is set on Mars and is about female astronauts. How might music develop in the noisy environment of a Martian base? As well as ordinary orchestration, it features industrial sounds, such as leaking helium cannisters. More will be revealed in July when the finished work, devised for the Irish National Opera, debuts in Galway, Ireland.

Mars is also a way into subjects from climate to life and non-life. Walshe's interests are wide, as my colleague Alex Wilkins noted (22 February, p 27) after hearing a talk by her at London's Institute of Contemporary Arts. Catch her on BBC Sounds – or plan a trip to see the opera.

BLACKIE BOUFFANT

The sci-fi column

Messing with Reality In his new novel *Dissolution*, Nicholas Binge plays with time travel and memory to craft a clever thriller reminiscent of *Memento* and *Inception*. It is well-deserving of its upcoming big screen treatment, says **Emily H. Wilson**

Emily H. Wilson is a former editor of *New Scientist* and the author of the *Sumerians* trilogy, set in ancient Mesopotamia. The second book in the series, *Gilgamesh*, is out now. You can find her at emilyhwilson.com, or follow her on X @emilyhwilson and Instagram @emilyhwilson1

VIRGILIO FERREIRA/MILLENNIUM IMAGES, UK

Time travel stories often trap characters in loops for our enjoyment

TIME travel is, of course, a staple of science fiction. The means of travelling through time may differ – from a 1960s police box to a set of ancient standing stones – but time shifting generally leads to all kinds of problems with "timelines" and important things being erased from or added to them. Our heroes can also get stuck in loops, doomed to repeat themselves endlessly for our pleasure unless they can work out how to escape. Think *Groundhog Day*, *Palm Springs*, *Edge of Tomorrow* and so on.

Memory problems are another great sci-fi standby. Why can't our hero remember anything? It is an instant mystery. Or perhaps they have selective memory gaps. Even more mysterious. Then there is the added benefit of reducing the hero to the same information level as the reader. Exposition can be extremely tedious when you are the only one in the dark, but very welcome when the hero has no idea what is happening either. Playing with amnesia storylines can also serve up big questions about what is left if we forget who we are and what we have done.

In *Dissolution*, Nicholas Binge cleverly weaves together time travel and memory games into a hard-to-put-down thriller. It's an expertly crafted puzzle of a story that reminded me of the films *Memento* and *Inception*, so I can see why the book is already being adapted for the big screen.

"Memory problems are another sci-fi standby... they reduce the hero to the same information level as the reader"

In *Dissolution*, our hero is, quite refreshingly, an elderly woman. Maggie's situation at first seems ordinary. Her only child doesn't speak to her and her husband Stanley is in a care home and has started to forget who she is. She is terribly lonely, but she slogs on. What else can she do?

Then a man, Hassan, turns up at her front door and claims that her husband is having his memories stolen. But we only learn this from a transcript of Hassan interviewing Maggie under bafflingly strange circumstances.

This is an ornately constructed book, full to the brim with plot and consisting of lengthy interview transcripts of pure dialogue, mixed up with glimpses into the past. In lesser hands, all this would be leaden and lumpish, but Binge is an excellent writer and more than up to the challenge of laying out the puzzle pieces for us. I won't say more about the plot for fear of ruining it, but if you like mysteries involving memory loss and time travel, this one is for you.

This brings me to another (very different) book about memory that is also out this month.

Murder by Memory, by the talented Olivia Waite, is a novella, and I am generally enraged by novellas. What is the point of a book that ends just as you are getting into it? However, if 100 pages is your ideal length and you also like the idea of cosy crime set on an interstellar starship, then this is definitely one for you.

The (delightful) hero is ship's detective Dorothy Gentleman, who wakes up in a body that isn't her own to find that someone has not only killed people on board, but is also destroying their stored memories, which means the victims are actually, really, murdered. Once she is sure that her own memories have been made safe, Dorothy sets out to track down the dastardly murderer.

The book is the first instalment in a new series, so perhaps at some point the stories will be collected into omnibus form (as has just happened with Martha Wells's *The Murderbot Diaries*) to stop people like me whining about how short they are. ▮

Book

Dissolution

Nicholas Binge

Harper Collins (UK, 27 March); Penguin Random House (US, 25 March)

Emily also recommends...

Film

Edge of Tomorrow

Doug Liman

Streaming on various platforms

A war against alien invaders is raging. Every time our hero, played by Tom Cruise, is killed, he wakes up alive... only to find himself shipped out to face the aliens once more. This is a superb example of a *Groundhog Day*-style time-loop story, and I don't know why it isn't more beloved. Plus, you get Emily Blunt as the ultimate alien hunter.

Editor's pick

End of the multiverse? End of a whole branch of sci-fi!

11 January, p 32

From Malcolm Moore, Rotorua, New Zealand

Are you kidding? No multiverse, no parallel Earths? Do the physicists killing off the many-worlds idea have no conscience? A whole subgenre of sci-fi is damned to extinction. Gone, vanished down a literary black hole with just a few dog-eared remnants littering the non-event horizon. Me? I'm just finishing an Adrian Tchaikovsky book involving… oh, never mind.

The truth is out there on modern ufology

8 February, p 21

From Ian Simmons, news editor at Fortean Times, *UK*

Ufological culture has always been concerned about governments hiding "the truth" and distrustful of scientific authority. That isn't new. The situation is complicated, though, by the dominant narrative about aliens and UFOs changing, moving from benign space brothers to evil greys and now to "disclosure", the idea that citizens can get authorities to reveal "the truth". Rather than being anti-science or anti-government, this treats both with a kind of reverence.

At least in the US, ufologists have gone from investigating phenomena to writing letters to get "all-wise" authorities to reveal "the truth", showing a somewhat touching faith in government procedures and scientific omniscience. Rather than being driven by a new anti-elite impulse, it is more a product of the social media age, where stories spread rapidly, believers can organise more effectively and rumours can be magnified fast. It is something the Trumpian right has exploited, not driven. US ufology seems more interested in evidence standards than before – at least today it seeks results from government labs.

On the divisions afflicting society

25 January, p 28

From Virginia Lowe, Melbourne, Australia

The only eco-novel of the many I have read that doesn't demonise climate deniers is *Flight Behaviour* by Barbara Kingsolver. Here, you can see their good intentions, their misunderstandings and their humanity, as author Kurt Gray shows in his book *Outraged*, reviewed on your pages. This made me realise I had been demonising them myself. There are other ways of sharing the burden of global warming. We are all human and all in this together.

'Useless' ear muscle gives me a sixth sense

8 February, p 19

From Gerald Legg, Hurstpierpoint, West Sussex, UK

I can slightly move the "useless" muscle that lets some people wiggle their ears. Of more interest is that I feel the muscle slightly twitch when someone/something approaches outside of my visual field. It feels almost like a sixth sense, but obviously it is linked to my auditory system picking up a sound I don't appear to actually hear and making my auricular muscles twitch – a bit like a dog "pricking" its ears up. Perhaps it's not such a useless muscle after all.

Another vote against fighting fire with fire

1 February, p 12

From Nina Burdett, Malmsbury, Victoria, Australia

In fire-prone southern Australia, intentional burning to combat wildfire risk is controversial. These burns run for weeks every autumn and the smoke is a health and environmental hazard.

The effect on wildlife and plants seems to be rarely taken into account. Fire does reduce fine, easily burned plant matter, but also prompts intense regrowth. Repeated burning leaves soil open to erosion and encourages annuals and fine-leaved perennials to flourish, adding to the fire risk. Lightning strikes are inevitable, but public education, sensible location of housing and encouraging weed-free old-growth forests go a long way to reducing the wildfire threat.

Defossilised polyester needs hot and dirty gases

Letters, 1 February

From Charlie Wartnaby, Cambridge, UK

LanzaTech's fermentation process to make "defossilised" polyester appears to need more reactive inputs, which is why it favours hot blast furnace exhaust that contains carbon monoxide and hydrogen, as well as carbon dioxide, rather than the cool, pure, waste CO_2 streams that reader Dave Covell suggested.

Sabre fangs perfect for making hominids a meal

18 January, p 19

From Richard Swifte, Darmstadt, Germany

Your article on sabre teeth reminds me of a visit I made to a fossil site in South Africa. Using a hominid skull and two curved fingers, a researcher graphically illustrated how a sabre-toothed tiger could leap on an unfortunate hominid from behind and grab its skull, with its two fangs nicely inserting into the eye sockets and through to the brain for an instant kill.

Surely it is all about degrees of consciousness

1 February, p 26

From Don Taylor, Cheadle, Staffordshire, UK

In his review of Jeff Sebo's book, Michael Marshall writes that we "can never be 100 per cent sure if another being is conscious". Perhaps we can if consciousness is a question of degree, a continuum of levels of awareness, not an either/or thing. Think back to your earliest childhood memory – it may be vague and episodic, but you were certainly conscious then, just not as conscious as now. Maybe those early memories give us an inkling of what it is like to be a chimp or an elephant. We can be reasonably sure that they are conscious to some extent.

Adventure and curiosity drive us to colonise Mars

Letters, 1 February

From Steph György, Sydney, Australia

Paul Friedlander says past colonisation has been a hunt for opportunities to trade or get rich, hence the same will apply to Mars. This leaves out one of the strongest drivers: curiosity/adventure. It is often assumed that billionaires are motivated by money, but if you look at Martian colony proponent Elon Musk's track record, he has, at numerous times, risked everything for projects that he truly seems to believe in. Maybe this time his belief is simply that humanity needs to exist beyond Earth.

Taking the sparkle off the cosmic gem

25 January, p 10

From Jim McHardy, Clydebank, West Dunbartonshire, UK

The odd gem-like shape created to simulate the fundamental nature of our cosmos just "knows about" fundamental principles of physical theories like quantum mechanics and relativity? This seems a little frightening.

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Resetting the immune system

In autoimmune conditions, the body attacks itself, with devastating results. But a raft of therapies that hit the reboot button promise lasting help, says **Jasmin Fox-Skelly**

PERE SANTAMARIA was 15 when he developed myasthenia gravis. This autoimmune condition causes extreme muscle weakness and can sometimes lead to breathing difficulties. In Santamaria's case, it affected the ocular muscles controlling his vision, making him see double.

"It had a tremendous effect on me personally," he says. "I was becoming an adolescent, and all of a sudden I couldn't play sports and I couldn't live a normal life. I had to take very high doses of corticosteroids, which made me swell up like a balloon."

Worse, these drugs only dampen down the body's general immune response, rather than addressing the causes of autoimmunity, meaning Santamaria had no expectation that taking them would ever cure his condition.

As the years passed, Santamaria developed additional autoimmune conditions – and a determination to learn more about them. "I just wanted to understand the diseases and mechanisms, with the hope I could eventually help others," he says.

He has now made progress towards that goal. Working as an immunologist at the University of Calgary in Canada, Santamaria is at the forefront of a push to develop new therapies to reprogram the immune system and encourage the human body to end its destructive war against its own tissues.

As those therapies move into clinical trials, there are promising signs. Indeed, some are so effective that a single dose has, in a few cases, left people symptom-free for years. So is the end of autoimmune conditions now in sight?

Our bodies have several lines of defence against pathogens. Physical barriers like the skin make it difficult for bacteria and viruses to access our internal tissues – and if they do, immune cells such as macrophages can make short work of the invaders by engulfing and digesting them. Such defences form part of our innate immune system, which is a relatively crude but effective way to deal with threats. "They just non-specifically kill the bad guys who don't look human," says Daniella Schwartz at the University of Pittsburgh in Pennsylvania.

But there is another, far more sophisticated branch of the immune system. Called the adaptive immune system, it is controlled by highly specialised white blood cells known as B- and T-lymphocytes. These B-cells and T-cells recognise molecules – known as antigens – on the surfaces of viruses and bacteria, ultimately using this information to destroy the threat. What's more, B- and T-cells can remember antigens, allowing them to respond quickly if they encounter a particular pathogen again in the future, which is the basis of vaccination.

Although this makes the adaptive immune system a powerful tool for fending off infections, it can also inadvertently cause problems. Some B- and T-cells recognise "self-antigens" – the molecules present on our own cells. Usually, they are programmed to tolerate them, but sometimes they begin to attack those cells instead of pathogens. The result is an autoimmune condition. "Any arm of the adaptive immune system can go wrong and lead to autoimmunity," says Schwartz.

"Many patients don't encounter a relapse or a flare-up of their original condition"

For example, the main cause of lupus – a potentially life-threatening condition that causes inflammation and damage to the skin, joints, heart, lungs, kidneys and brain – is dysfunctional B-cells that produce antibodies against a person's own DNA. Type 1 diabetes, meanwhile, begins when T-cells attack the insulin-producing cells in the pancreas.

It is still unclear exactly what triggers autoimmune conditions. "At the moment, they are thought to be the result of interactions between genetic and environmental risk factors, and those vary from person to person," says Frederick Miller, former head of the Environmental Autoimmunity Group at the National Institutes of Health in North Carolina.

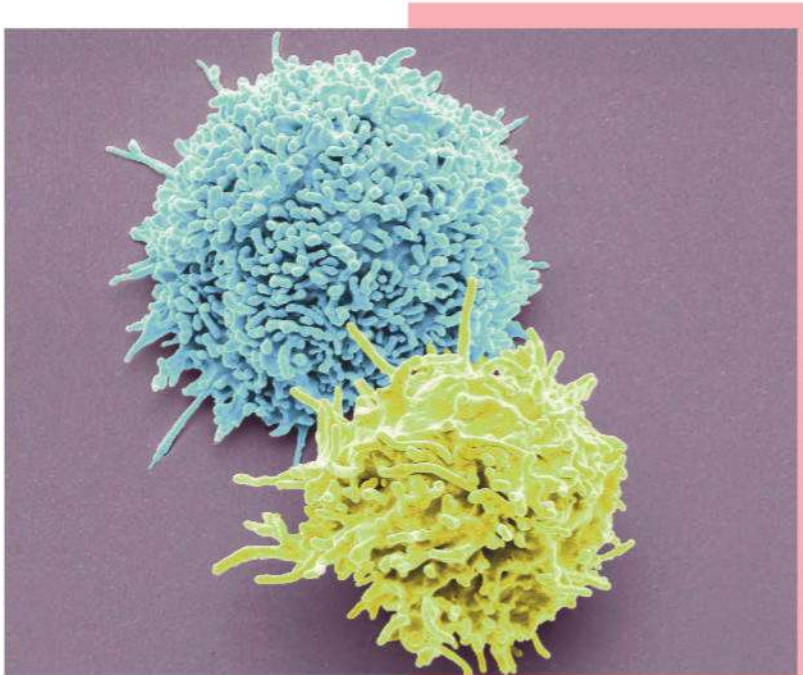
We do know that autoimmune conditions typically don't arise overnight. Instead, says Miller, they seem to develop over years – or even decades – from the complicated interplay between risk factors. The resulting conditions can be extremely debilitating. "These are diseases that consume you," says Santamaria. "They have a devastating impact on patients and their families."

Traditional treatments that dampen down all immune activity – such as the one Santamaria was placed on – can ease symptoms. But they do so at a price. "The treatments work fairly well, but they increase the risk of infections and cancer in the long term because they basically suppress your entire immune system," he says.

Because of this, it would be preferable ›

ANDREW HUDSON

MS
RHEUMATOID
ARTHRITIS
COELIAC DISEASE
TYPE 1 DIABETES
LUPUS



STEVE GSCHMEISSNER/SCIENCE PHOTO LIBRARY/ALAMY

Reprogramming T-cells – pictured here – can prevent the immune system from attacking the body

to somehow restore the body's tolerance for its self-antigens, either by eliminating or reprogramming the rogue immune cells responsible for autoimmunity. After 50 years of research towards this goal, there are signs it could finally be in reach.

For instance, CAR-T (chimeric antigen receptor T-cell) therapies, which have already proved successful at beating some blood cancers, are showing promise as a treatment for lupus. This version of CAR-T therapy involves harvesting T-cells from an individual with lupus before growing and engineering them in a lab so that they express a special protein receptor known as a CAR. The cells are then re-infused back into the individual, where they recognise and destroy B-cells, including those that are the main cause of lupus. The body then produces a replacement population of B-cells, making this therapy a bit like hitting the reset button on the immune system, restoring it back to its factory settings.

What makes CAR-T therapy so exciting, says Schwartz, is that – in some people – it seems to have a permanent effect. "The therapy depletes a big chunk of the B-cells and it looks like the [lupus-causing] reactive B-cells, for whatever reason, don't grow back," she says.

In a study published in 2022, researchers gave CAR-T therapy to five people with severe lupus. All five experienced remission and were able to stop taking their usual medication – such as the immunosuppressive drug mycophenyolate. According to Georg Schett at Friedrich Alexander University in Germany, who led the clinical trial, some of the participants remain symptom-free today, almost four years after receiving just one infusion of CAR-T therapy. "The immune reset is extremely effective, which makes sense because it isn't easy to build up an autoimmune disease from scratch, and several checkpoints need to be passed to trigger the disease," says Schett. "The same process does not seem to happen again. That's why [many] patients do not encounter a relapse or a flare-up of their original disease."

Temporary wipeout

On the back of these promising results, Schett and his colleagues have begun a clinical trial involving people with several other autoimmune conditions. CAR-T therapy for lupus is also now the subject of a phase I clinical trial led by University College London and the University College London Hospitals NHS Foundation Trust, where the aim is to assess safety and establish effective doses in a small number of people with the condition.

Such trials are vital because CAR-T therapy can cause serious side effects – it can even lead to death from infection after B-cells have been wiped out. Furthermore, the long-term impact of deleting those immune cells – albeit temporarily – is unknown. CAR-T therapy is also expensive, with each infusion costing an average of more than $600,000. "I think we're still going to see these as rather expensive treatments that maybe not all patients will have access to because of the cost," says Miller.

The good news is that other, potentially cheaper and safer treatments are in the pipeline too. Rather than inhibiting or killing immune cells, these aim to boost immune tolerance. Santamaria, for example, is developing a new class of nanomedicines called Navacims. These tiny particles reprogram a class of T-cells that, in many autoimmune conditions, are the ultimate source of the problem.

The cells in question, T follicular helper cells, are found in the spleen, tonsils and lymph nodes, where they help B-cells make antibodies against pathogens. However, in many autoimmune diseases, including rheumatoid arthritis, the T follicular helper cells malfunction and encourage B-cells to produce antibodies against a self-antigen. These antibodies act like beacons, drawing an army of white blood cells to the site, which then act on the signal and attack body tissue.

The Navacims can halt this process. They are coated with the self-antigen being targeted, which means they are recognised by the rogue T follicular helper cells. But the Navacims are present in such unnaturally high concentrations that the T follicular helper cells become overwhelmed. This has the surprising effect of prompting them to transform into a totally different type of cell, known as regulatory T-cells, which suppress rather than promote an immune response. "The Navacims can reprogram those aggressive cells and turn them into protectors," says Santamaria.

Once reprogrammed, the regulatory T-cells multiply, eventually forming an army of white blood cells that ease autoimmunity-triggered inflammation. Because these cells only travel to sites of inflammation associated with the self-antigen, they have a localised effect, while the immune system in the rest of the body continues its job of fighting off infections and cancer.

So far, Navacims have been shown to be effective in animal models of liver autoimmune diseases, type 1 diabetes, inflammatory bowel disease, rheumatoid arthritis and multiple sclerosis. A phase I human trial is now under way for autoimmune diseases of the liver.

And speaking of the liver, the organ is at the centre of perhaps the most exciting approach to tackling autoimmune conditions. The liver sits at a crucial position in the body, functioning as a junction between the gut and the blood system. Eighty per cent of the blood entering the liver comes from the gut and, significantly, that blood is full of antigens from broken-down food and gut bacteria. In addition, the liver is also where old,

damaged blood cells are sent for disposal – a process that releases even more self-antigens into the bloodstream. To stop all these antigens from sending the immune system into overdrive, the liver has evolved to be an easy-going place. "When antigens are detected there, the immune response is biased more towards tolerance," says Jeffrey Hubbell at New York University.

Inverse vaccines

Once antigens are detected in the liver, a special type of immune cell, known as an antigen-presenting cell, displays them to T-cells. Elsewhere in the body, this is an important part of the typical immune response and can result in a desired attack, but in the liver, the immune system responds by generating regulatory T-cells – similar to those that Navacims help produce. And just as in the Navacim approach, these regulatory T-cells dampen down the inflammatory response.

Hubbell wondered if he could take advantage of this process to design a kind of "inverse vaccine". Unlike normal vaccines, which teach the immune system to recognise and attack an antigen associated with a particular pathogen, an inverse vaccine does the opposite: it erases the immune system's memory of a self-antigen that is triggering an autoimmune response.

The inverse vaccine designed by Hubbell and his team works by attaching the self-antigen in question to a polymer. The polymer is also coupled to a sugar molecule known as N-acetylgalactosamine, which is similar to those found on fragments of old cells, so the body sends the polymer to the liver to be cleared away. Once there, the antigen-presenting cells and regulatory T-cells ensure that the self-antigen on the polymer is recognised but tolerated by the immune system.

In a 2023 study, Hubbell and his colleagues used the approach to treat mice with a multiple sclerosis-like disease. In multiple sclerosis, rogue T-cells attack myelin, an insulative coating surrounding neurons, leading to progressive weakness and numbness, and potentially paralysis and death. To create the inverse vaccine, the team linked myelin proteins to the polymer. In mice given the treatment, the immune cells stopped attacking myelin, allowing the neurons to recover and function correctly.

Significantly, this reduced levels of inflammation – and symptoms of disease in the mice began to reverse. "The reason we were so excited about our results is that we saw a real therapeutic effect," says Hubbell. "You could take animals that were a full-on immune mess and improve their symptoms with just one course of treatment."

"The 50-year quest to restore the body's tolerance to its own tissues is finally nearing its end"

A phase II clinical trial using a similar technology and concept is currently being carried out in people with coeliac disease, an autoimmune condition associated with an intolerance to gluten, with a phase I safety trial also underway in people with multiple sclerosis. The trials are being conducted by Anokion SA, a pharmaceutical company based in Switzerland that Hubbell co-founded.

Meanwhile, German biotech firm BioNTech is exploring whether the mRNA technology that proved so successful against covid-19 could help tackle autoimmune diseases. Here, the idea is to use mRNA to increase the production of regulatory T-cells for a particular self-antigen, with the aim of teaching the body to avoid attacking it.

Therapeutic approaches based on the production of regulatory T-cells have one key advantage over other approaches: they don't require you to treat – or even to understand – all the causes of a particular autoimmune condition. This is important because, although an autoimmune condition may begin with an attack on just one self-antigen, as time goes by, the assault broadens and involves many of them. Crucially, however, regulatory T-cells that target just one self-antigen can dampen down the inflammation associated with all of them. "The exciting thing about regulatory [T-cell] approaches is that they have the potential to suppress immunity to antigens that you don't know exist and that you may never know exist," says Hubbell.

With so many therapies in development, it looks like the 50-year quest to restore the body's tolerance for its own tissues is finally nearing its end. Santamaria is cautiously optimistic that one day soon, teenagers diagnosed with conditions like myasthenia gravis will be able to take treatments that allow them to live a normal life, without raising their risk of infection and cancer.

"Of course, we need to carefully advance these treatments through clinical trials to ensure safety and proof of concept, but from what I have witnessed in many animal models of autoimmune disease, I know there is a path forward to tame these diseases," he says. "I am very hopeful." ▮

A patient gives a blood sample for CAR-T therapy (top); the blood is passed through a centifuge before being genetically modified (bottom)

GERARD JULIEN/AFP VIA GETTY IMAGES; LUCY NORTH/PA IMAGES/ALAMY

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Frozen in time

Permafrost mummies of extinct animals are painting a rich picture of a prehistoric ecosystem, says **Graham Lawton**. Could ancient humans be next?

GOVERNMENT OF YUKON

THE ivory hunters knew they had found something special. It was 2020 and they were tunnelling into the banks of the Badyarikha river in Siberia. The permanently frozen soil of the river basin is a rich hunting ground for woolly mammoth tusks, which fetch a pretty price on the Chinese ivory market. Occasionally, however, rarer treasures turn up – more complete remains of mammoths and other long-dead animals.

This, however, was on a different planet. Inside a block of ice, the prospectors spotted a furry carcass unlike anything they had seen before. They alerted scientists, and eventually the ice block reached Alexey Lopatin at the Borissiak Paleontological Institute in Moscow for analysis. Last year, he and his team concluded that the remains were those of a juvenile scimitar-toothed cat, an animal only distantly related to living cats, and one that hunted like no predator does today.

"For the first time in the history of palaeontology, the appearance of an extinct mammal that has no analogues in the modern fauna has been studied," says Lopatin. "It's a fantastic feeling."

And it is one that might become more familiar to palaeontologists in the years ahead. Although frozen mummies have been emerging from the permafrost of Russia and North America for two centuries, we entered a golden age of discovery about 15 years ago. In that time, some of the finest known woolly mammoth mummies have come to light, as well as the first mummies of predators including wolves and cave lions. There are high hopes of more – potentially even the first frozen mummies of Stone Age humans.

Knowledge of permafrost mummies stretches deep into the frozen mists of time. In the late 1690s, Danish merchant-adventurer Evert Ysbrants Ides, who had somehow been appointed Russia's envoy to China by Peter the Great, spent three years schlepping overland from Moscow to Beijing via Siberia. His 1704 travelogue reports that many of the region's people knew of – and feared – huge corpses emerging from river banks. Folklore had it that they were gigantic subterranean beasts that expired when exposed to light, and that people who encountered them fell ill and died.

His book also contains the first contemporary description of a permafrost mummy, a rotting carcass of a "mammut" discovered in 1692 on the banks of the Yenisey river. A local man told him that the animal's forefoot had the girth of a man's waist.

In 1722, perhaps inspired by his envoy's account, Peter the Great issued a decree for the collection of natural curiosities, including the remains of mammoths, to fill his Kunstkamera (museum of curiosities), then under construction in St Petersburg. But he died in 1725 with his mammoth ambition unfulfilled.

In fact, the collection and study of permafrost mummies would remain a frustratingly difficult task for another 200 years, partly because the ancient remains typically occur in locations that aren't easily accessible to scientists. For instance, in 1799, a mammoth mummy – the first known to science – was spotted on the banks of the Lena river in Siberia. Early reports suggested it was nearly intact, but by the time biologist Mikhail Adams got there in 1806, it was in poor condition. The tusks had been removed and much of the soft tissue, including the trunk, had rotted away or been eaten by scavengers. Nevertheless, Adams recovered a portion of skin, bundles of wool and the rest of the skeleton, then dispatched them to St. Petersburg.

According to a 1929 paper by biologist Innokenty Tolmachoff, around 30 more mammoth and rhino mummies were reported in the century after the Adams mammoth, but most were lost to science due to their remote location. Many more mummies were probably kept secret or destroyed, Tolmachoff speculated. An exception is the Berezovka mammoth, which was found in a sitting position in 1900, excavated in 1901 and sent (in parts) to the Zoological Museum in St. Petersburg. It still had vegetation in its mouth and an erect penis, indicating a sudden death, possibly by asphyxiation.

But money talks, and in 1938 the president of the USSR Academy of Sciences offered a reward of up to 1000 roubles – roughly £20,000 in today's money – to any citizen who reported the remains of a mammoth, rhino or other animal to him, either by radio or mail. Gold mining arrived in the far north of Russia and North America at this time, too, and together these initiatives "brought forth recovery of significant numbers of Ice Age mummies", according to a recent publication by Olga Potapova at the Pleistocene Park Foundation ›

This mummified wolf pup, found in Yukon, Canada, is 57,000 years old

"The icing on the cake would be the permafrost mummy of an ancient human"

and Eugene Potapov at Bryn Athyn College, both in Pennsylvania. Thus began the first golden age of mummy discovery.

Up to that point, mummies of only three species that had lived during the last glacial period more than 10,000 years ago were known: mammoths, rhinos and a small, rabbit-like animal called a pika. But over the following decades, eight more were added, including wild horses, musk oxen, stag-moose and steppe bison.

Media sensation

Many of the discoveries became famous worldwide, such as Effie the baby mammoth, found in 1948; the Selerikan horse in 1968; another baby mammoth, Dima, in 1977; and a near-complete steppe bison found in a gold mine in Alaska in 1979, dubbed Blue Babe because it was coated in vivianite, a blue iron phosphate mineral.

Most permafrost mummies date from the latest part of the Pleistocene Epoch, which lasted from around 2.58 million years ago to 11,700 years ago and is commonly called the Great Ice Age. The earliest known exceed 50,000 years old, right on the edge of the range of radiocarbon dating. The latest are from the Holocene Epoch, which followed the Pleistocene. But the majority are from the period before the last glacial maximum, which occurred around 26,000 years ago.

During that time window, much of the northern hemisphere was buried under ice sheets, but to the south lay a ribbon of land called the mammoth steppe, a cold, dry, treeless grassland stretching around the globe between present-day Siberia and the territory of Yukon in Canada.

This ecosystem was dominated by megaherbivores, such as mammoths, woolly rhinos, musk oxen, bison and moose, as well as the carnivores that preyed on them: cave lions, wolves, bears, cave hyenas and scimitar-toothed cats. There were plenty of smaller creatures in this landscape too, such as wolverines, hares, ferrets, lemmings, ground squirrels, pikas and birds.

Occasionally, these animals met a suffocating end, trapped in mud, water, crevices or collapsed burrows from which they couldn't escape. Even more rarely, their whole or partial bodies were frozen, entombing them in ice or permafrost (defined as ground that stays below 0°C (32°F) for at least two consecutive years). Such frozen mummies can survive for thousands of years until they re-emerge from their frigid tombs, perhaps when a river cuts through the permafrost or when prospectors excavate the sediments in search of ivory or gold.

Some of the species preserved as permafrost mummies still exist, and most of the extinct ones have modern analogues. Mammoths, for instance, are closely related to Asian elephants and are anatomically similar in many ways. Even so, the mummies of extinct species contain information that can't be obtained from skeletal remains or living relatives.

"The big value is to actually see the real morphology," says Love Dalén, an evolutionary geneticist at the Swedish Museum of Natural History in Stockholm. "For all these frozen mammoths that we found, there are many things we would never have known about, for example that they have this kind of finger-like protrusion on the trunk, the size of the ears and stuff like how short the tail was."

That information is useful for Colossal Biosciences, a US biotechnology company attempting to de-extinct the woolly mammoth. "It tells you what phenotypes you should look for," says Beth Shapiro, the company's chief science officer. "It sure is nice to have some actual hair to look at and see the shape and the texture and how it was distributed around the body." The mummies are also a source of ancient DNA that is often in better condition than any that can be extracted from bones and teeth, says Dalén.

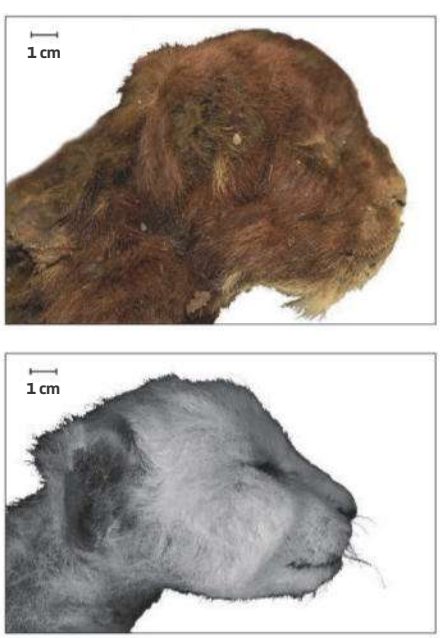
By the end of the 20th century, permafrost mummies belonging to 12 species, all herbivores, had been recovered from permafrost. But most were in quite poor condition. Of 38 specimens in total, only eight were complete – meaning that 90 per cent or more of the animal was intact – and four of those were ground squirrels or voles. The larger intact specimens were two mammoths (Dima and Masha), a woolly rhino (Starunia 2) and Blue Babe.

In the past 15 years, the species count has jumped to 19 and now includes five mammalian predators and the first non-mammal, a lark. The number of complete specimens has leapt too. It now stands at 22, and the number of mammoth specimens has more than doubled.

This second golden age of mummy discovery is largely down to increased levels of ivory hunting in Siberia and gold mining in the Klondike region of Yukon, says Dalén. The former is driven by demand from China, which banned the sale of elephant ivory in 2017. Although there is plenty of illegal prospecting for mammoth ivory, prospectors can also operate legally if they allow local scientists to join their expeditions.

The first groundbreaking discovery of the 21st century was the Tumat wolf in 2011, the first predator to be found mummified. The grey wolf – the same species as the living *Canis lupus* – was around 3 months old when it died some 12,500 years ago. Four other grey wolf pups, one of them more than 50,000 years old, have since been found in Yukon (pictured on page 30) and in the region of Yakutia in Russia. In 2019, the severed but intact head of an adult wolf, complete with fur and teeth, was found in Yakutia.

This scimitar-toothed cat cub found in Yakutia, Russia (top), bears many similarities with a modern lion cub (bottom)



A. V. LOPATIN ET AL. (2024)

LEOPOLD NEKULA/SYGMA VIA GETTY IMAGES

Scientists hope to discover human mummies older than Ötzi, which is 5300 years old

More predatory species have emerged too. One of the Pleistocene's apex carnivores was the now-extinct cave lion, a robust big cat closely related to today's lions, at first known only from sporadic discoveries of teeth and isolated bones. In 2015, two mummified cubs were found side by side in a collapsed den in Yakutia. Named Dina and Uyan, they were just a week old when they died 30,000 years ago. Two more cave lion cubs, Boris and Sparta, turned up in a different location in 2017 and 2018, though they lived tens of thousands of years apart. The mummified remains of a bird, later identified as a horned lark that lived around 45,000 years ago, were found in the same location in 2020. Other recent complete specimens include the Anyuy steppe bison, a 48,000-year-old adult male found in a river in Yakutia; the Batagai foal, a young Lena horse; and three infant mammoths.

The jewel in the crown, however, is the scimitar-toothed cat cub unveiled last year (pictured, left). The rear end of the animal is missing, but the chest, front legs and head are preserved in exquisite detail, including the stubs of its whiskers.

From an anatomical examination, Lopatin and his colleagues identified the cub as a juvenile *Homotherium latidens*. Radiocarbon dating suggests that it died roughly 37,000 years ago. "We don't know the cause of its death, but we can assume that it quickly became covered with sediment and froze into the ground," says Lopatin.

Concealed teeth

H. latidens is an extinct relative of the more famous (and also extinct) sabre-toothed cat *Smilodon*. The former lived across Eurasia, North America and Africa during the Pleistocene, dying out around 12,000 years ago. Skeletal remains aren't uncommon, but the discovery of a mummy – even half a juvenile one with unerupted teeth – adds a great deal to our knowledge of these charismatic and fearsome carnivores. "The muscles, skin and fur of the mummy were well preserved," says Lopatin.

The team showed that the ancient cub had an unusually large upper lip – twice the height of those of similarly aged lion cubs – presumably so that adult *H. latidens* could cover and protect their large canines. This is in line with a 2022 study that inferred from fossils that *H. latidens* concealed its teeth when its mouth was closed.

The permafrost mummy also had unusually wide paws, perhaps an adaptation to walking in snow. Its fur, a chocolatey brown, lacked the spotted or striped camouflage often seen in young cats today. It is unclear why. Had the cub lived, it would have grown into a robust lion-sized cat with massive neck muscles and long, curved canines, both thought to be adaptations for bringing down large prey. "It's pretty cool," says Dalén.

Despite the recent advances, there are holes the mummy hunters would dearly love to fill. Cave bears remain stubbornly elusive. And Lopatin says he is hoping for a specimen of the "super huge" *Elasmotherium*, an elephant-sized, long-legged rhino. Dalén thinks that we can go much further back in time: he and his colleagues recently found a lemming mummy in the Batagaika crater in Sakha, Russia, which is roughly 300,000 years old, suggesting there is a possibility of finding larger-bodied species from around that time. He would also love to see the mummy of an adult cave lion, to test his hypothesis that they turned white in winter.

But the icing on the cake would be a permafrost mummy of an ancient human. Ötzi, a frozen mummy discovered in the Alps in 1991, continues to be a rich source of information on ancient human life. But it is "only" 5300 years old, a resident of the European Copper Age. Permafrost human mummies could be much older. "We know that modern humans were up there [in Siberia] already 30,000 years ago," says Dalén. A human mummy of such antiquity would provide us with an unprecedented glimpse into the Eurasian Stone Age – and potentially offer important data on a human population that included the ancestors of the first Americans. More speculatively, it is even possible that there are permafrost Neanderthal or Denisovan mummies out there, although there is no evidence that these ancient humans lived so far north.

"To me, it is surprising that some sort of frozen hominin hasn't been found yet," says Dalén. "I've talked to the Russians about this, and the answer I get is actually a bit mysterious. What they say is, well, we are also surprised. But for the locals up there, finding a human is a huge taboo. It's quite possible that they have found humans, but they will not tell anyone about it. The rumours I'm hearing is that maybe they have been found..." ▮

Graham Lawton is a staff writer at *New Scientist*

IBRAHIM RAYINTAKATH

Mirror life

Grave warnings have been issued about the dangers of creating life forms using mirror-image molecules. How worried should we be, asks **Michael Marshall**

IN THE coming decades, we might figure out how to make an entirely new kind of life: a mirror cell, in which every molecule is the mirror image of those found in normal cells. Such reversed cells have probably never existed on our planet in its 4.5-billion-year history. Yet we could one day make them – perhaps as a way to develop new drugs, or simply out of pure scientific curiosity about the origins and evolution of life.

But should we? According to a coalition of synthetic biologists and biosafety specialists, the answer is a resounding "no". Mirror life, they argue, would pose "unprecedented risks" to the health of every living organism on Earth. If it ever escaped, we might never be able to recapture it, leading to "pervasive lethal infections".

It's an apocalyptic-sounding threat, but would it really be as dangerous as the team argues if we managed to create these new life forms? And although mirror life could be decades away, might there be things we can do now to reduce the risks it poses?

Many of the essential molecules of life can exist in two mirrored forms, like a person's left and right hands. While these "chiral" molecules are difficult to distinguish from each other, their distinct shapes cause them to behave differently. No matter how much you rotate a left-handed molecule, you will never get it to match a right-handed one.

In all living organisms on Earth, DNA is right-handed and proteins are left-handed. This arrangement seems to have been adopted very early in the history of life, and happened because living systems need consistent chirality to work effectively. The molecules in our cells must fit together neatly – sometimes as precisely as a key in a lock – so a jumble of left- and right-handed molecules would gum up the works.

Nobody knows why life chose this particular pattern of handedness. It may have been an arbitrary choice that became fixed over the course of evolution: a frozen accident. If that's true, life elsewhere in the universe might use molecules with opposite-handedness relative to life on Earth. Alternatively, there may be some subtle advantage to right-handed DNA and left-handed proteins, which enabled this form of life to outcompete its mirror image.

To explore these questions, biochemists have developed ways of making mirror molecules. Entire right-handed proteins have been constructed, as have left-handed nucleic acids – the building blocks of DNA – and, once assembled, the mirror molecules are perfectly functional. In a 2016 study, Ting Zhu, now at Westlake University in Hangzhou, China, and his colleagues created a mirror DNA strand that could be copied by a mirror enzyme.

Separately, synthetic biologists have been modifying living cells in ever more ambitious ways. As early as 2010, researchers led by Craig Venter at the J. Craig Venter Institute in La Jolla, California, removed all the DNA from a bacterial cell and then replaced it with a genome they had synthesised themselves. Subsequent studies have given cells heavily edited genomes, simpler than those found in nature. Ultimately, this could enable researchers to build an entirely synthetic cell: that is, assemble a living cell from scratch, using synthesised chemicals.

"The core of biochemistry for 50 years has been reconstituting activities that go on in cells," says Jack Szostak at the University of Chicago. "The ultimate of that would be to reconstitute the whole cell."

This means, argues Szostak, that we are approaching a convergence point. As we get better at making mirror molecules and figuring out how to build synthetic cells, there will come a point when we are able to construct a mirror cell: one where the DNA, proteins and other chiral molecules all have the opposite-handedness of existing life.

Safety first

Such cells are "probably quite some ways off", says Szostak. Estimates vary between 10 and 50 years, depending on how many of the steps prove to be easy or difficult. "If there are only a few hard parts, who knows?"

That's why Szostak and 37 co-authors, including Venter, teamed up to consider the potential benefits and risks of creating mirror life. Their conclusion, published in *Science* in December 2024, is that "mirror bacteria and other mirror organisms should not be created", due to the dire risks they pose.

In theory, many types of mirror life could be constructed. However, most would be either harmless or enormously difficult to make. For instance, it should be possible to make a mirror virus, because viruses are much smaller and simpler than cells: just a piece of nucleic acid surrounded by a protein shell. However, viruses can reproduce only by infecting cells and taking over their machinery – and because chiral molecules like DNA are involved throughout, this infection "should be totally impossible", says Szostak. "A mirror virus can only grow in a mirror cell."

In contrast, mirror animals and plants would be enormously difficult to construct, because they are made up of larger and more ›

complex eukaryotic cells. "That seems much harder and much further away," says Szostak.

That's why Szostak and his colleagues focused on the creation of a mirror bacterium: a single-celled organism, of a type that dates back billions of years to the earliest life on Earth. A mirror bacterium, they say, is something we should not make – for our own safety.

Not that Szostak believed that when he first started thinking about mirror life. Disease-causing pathogenic bacteria have specialised equipment to evade their host's immune systems and attack its tissues. Much of this equipment relies on chiral molecules. "When I first started getting involved in this, my initial reaction, like I think almost everybody, is that to be a pathogen is a highly evolved state," says Szostak. "You might think, well, there's no way that a mirror bacterium could be a pathogen."

However, he and his colleagues concluded that a mirror bacterium needn't be a specialised pathogen to cause serious harm.

The immune system recognises bacteria by locking onto telltale molecules on their outer walls, and those molecules are all chiral. As a result, a mirror bacterium would probably go undetected by our immune systems and wouldn't be cleared out of our bodies.

The bacterium would then have to locate food. Some nutrients found in our bodies, like the amino acid glycine, are non-chiral, so the mirror bacterium could feed on them. "The concentrations are lower and the nutritional value is probably not as good as something like glucose," says Szostak. This might mean the mirror cells grow only slowly. However, "the fact that they're not being killed off means that they could potentially grow without limit".

Furthermore, the mirror bacterium wouldn't be confined to a single type of host, unlike pathogenic bacteria, which tend to infect a limited number of species. In theory, mirror bacteria could grow in any living organism and in any ecosystem. Szostak and his colleagues write: "We cannot rule out a scenario in which a mirror bacterium acts as an invasive species across many ecosystems, causing pervasive lethal infections in a substantial fraction of plant and animal species, including humans."

As a result, mirror bacteria would act as pathogens with an "unusually broad host range", says Filippa Lentzos at King's College London.

The worry is that a mirror bacterium might escape from the lab where it was created and wreak havoc. Laboratories can be designed to be highly secure, but accidents can and do happen. And there is an even more dramatic scenario: mirror bacteria could be weaponised by a rogue government or terrorists.

Once mirror bacteria were out in the wild, they would be very difficult to control. In theory, we might synthesise mirror antibiotics to kill them, but these wouldn't be a panacea. "You could protect a small number of people or animals, but there's no way to deploy something like that on a global scale," says Szostak.

That's the case for the prosecution. However, specialists in biosafety and biosecurity contacted by *New Scientist* expressed conflicting views about mirror life. Because mirror bacteria do not yet exist, there is great uncertainty about their potential risks.

The first disagreement is over whether it is worth having the discussion at all, when mirror life may be decades away.

"No one in the world has come close to creating a cell from scratch," says Markus Schmidt at Biofaction, a research and science communication company based in Vienna, Austria. Rapid progress in synthetic biology notwithstanding, our inability to make synthetic cells "tells us that we actually do not really understand very well how the cell works". Consequently, Schmidt says, "we are very, very far away" from building a mirror bacterium. There are far more pressing biological challenges, he says.

"A mirror bacterium would probably go undetected by our immune system"

STOCKTREK IMAGES, INC./ALAMY

A rogue state could use mirror bacteria as a biological weapon

In contrast, Lentzos says raising the issue early is "exemplary". She points out that scientists developing new technologies have tended to engage the public only once they are ready to take them to market – by which stage people have attached their careers to the technique and large quantities of money are involved. "You're at the very end of it, and then nothing's going to change, whatever people say," she says. Better to raise the concerns "really far upstream", she argues. "To me, this is a textbook case of responsible science in action."

The second point of contention is whether mirror bacteria would really be able to make a living in our bodies, or anywhere outside of a controlled laboratory. "Maybe they just die when they're in the environment," says Kathleen Vogel at Arizona State University.

It's true that organisms produced by synthetic biology tend to be rather fragile compared with wild ones. "If somebody wanted to make a mirror bacterium, maybe just to show that they could, the first thing that was made would probably be quite crippled," says Szostak. Then again, a team skilled enough to make a mirror

ANDREE MARTIS/MILLENNIUM IMAGES, UK

Many molecules of life can exist in two mirrored forms, like a person's left and right hands

bacterium could probably also design it to be more resilient.

There are also many ways the mirror bacterium could be engineered to enable its confinement. For instance, the cell could be designed to be entirely dependent on a single nutrient not found in nature. "When you don't feed it, it's not going to survive," says Schmidt.

Alternatively, the cells could be given a ticking clock, so that they self-destruct after a specified amount of time. They could even be engineered to work using a different genetic code, incompatible with that used by all existing organisms. By stacking up several such control mechanisms, the odds of the mirror cells roaming unchecked could be rendered infinitesimal.

In short, it isn't inevitable that a mirror bacterium would survive in the wild, and a responsible creator could engineer the cell to make it less likely to cope.

However, that presumes the people creating the mirror bacterium have humanity's best interests at heart. "It might be someone with more sinister intentions," says Lentzos. In the most extreme scenario, someone might engineer mirror bacteria to be pathogenic – essentially, using them to commit mass murder.

We do have laws prohibiting such weapons. The Biological Weapons Convention, which entered into force in 1975, completely prohibits biological and toxin weapons. "The words 'mirrored bacteria' are not in that text," says Lentzos. However, "the text of the convention is broad enough to cover that".

Malicious intent

The problem is enforcing the existing laws. "If you really start to think about somebody malicious doing this, that's really, really hard to stop," says Szostak.

However, Vogel says the sheer difficulty of making such a weapon could itself be protection. "Solid empirical evidence tells you that creating a biological weapon to cause mass casualties is an extremely technically difficult thing to do," she says. "Even states who had all of the resources, all of the expertise, all of the infrastructure, all of the equipment, struggled in their efforts." Again, this is because living organisms are often very particular about the conditions in which they can survive, and engineered organisms are especially fragile.

"There are a lot of things that have to come into play for this to work," says Vogel.

But just because it hasn't happened yet doesn't mean it never will.

Despite mirror bacteria's dangers, we might want to risk making them if they offer significant benefits. However, the consensus is that the benefits are small or non-existent.

"You could use mirror bacteria as a sort of biofactory to make mirror molecules," says Szostak. Those mirror molecules can be genuinely useful, notably as long-lasting pharmaceuticals that don't get degraded by our immune systems. "But I think that benefit is actually pretty small, because the technology for just chemically synthesising mirror molecules is already pretty good," he says.

The only other benefit is pure curiosity: what would a mirror cell be like? Would it behave any differently compared with its reverse twin?

Consequently, Lentzos says the risk-reward calculation is clear. "I agree with the conclusion that we should ban this kind of research," she says. "You do need to weigh up the risks and potential benefits, and in this case the potential benefits are fairly limited, and the risks are very large."

For Schmidt, the discussion of mirror life is part of a bigger issue: containment of synthetic and modified organisms of all kinds. He says that many of the purported risks of mirror life could also apply to other kinds of synthetic and modified cells. "If you make something different, you run into the same concerns as with mirror life."

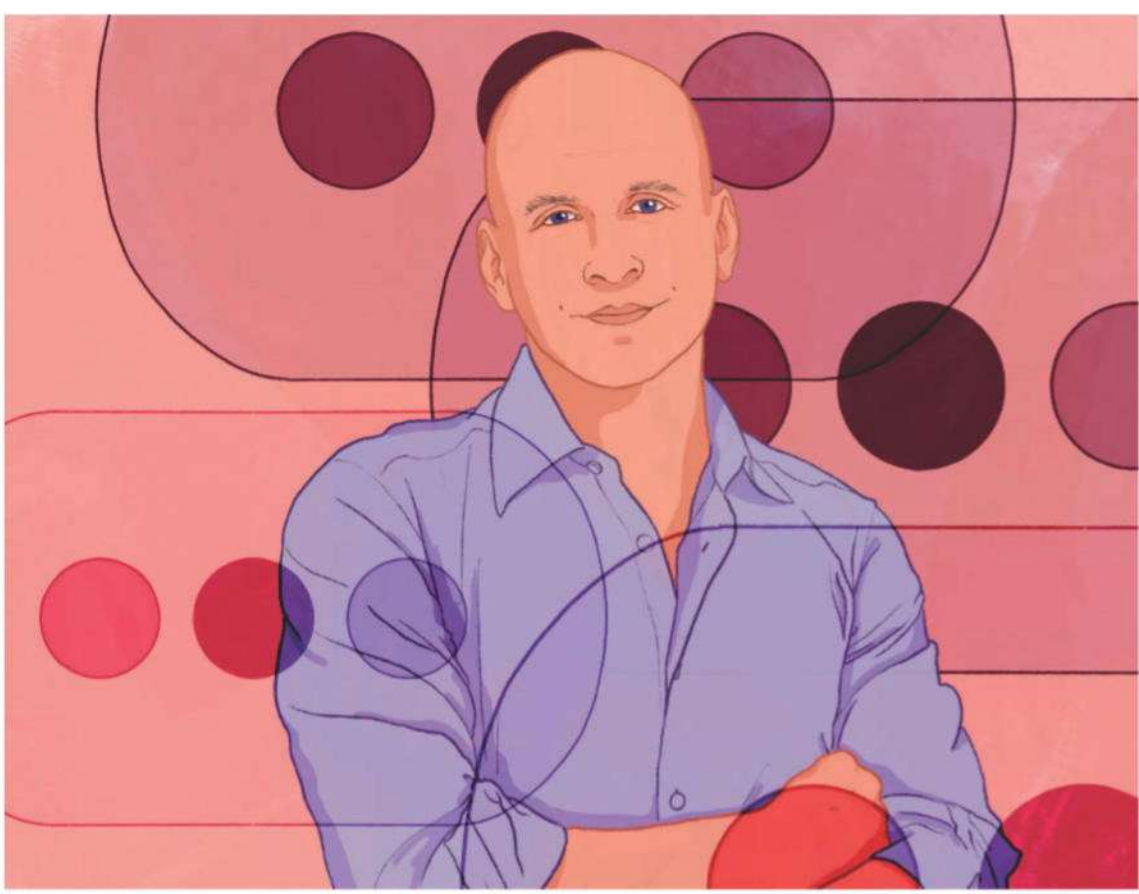
Synthetic biology is proceeding at a rapid pace, with all kinds of modified biomolecules and organisms being developed every year. Yet not enough effort is being put into developing containment systems, says Schmidt. He wants to see much more attention and investment directed towards biosafety, with the aim of developing a suite of methods to restrain synthetic and modified organisms, either physically or otherwise.

Mirror bacteria, in this view, are just one of many kinds of synthetic organisms we will build over the coming years – and they all need to be carefully managed. As such, the level of existential threat posed by these possible new forms of life is in our hands. ▮

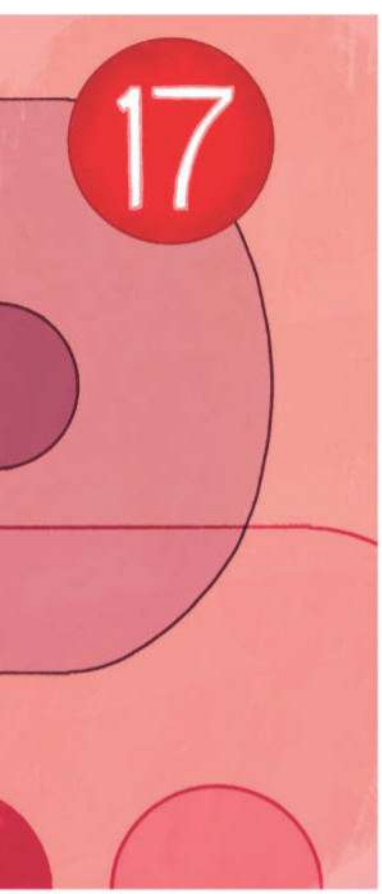
Michael Marshall is a freelance writer based in Devon, UK, and author of *The Genesis Quest*

"People tend to be thoughtless when they are choosing how to communicate at work"

Andrew Brodsky has studied how 100,000 people converse in their jobs. He tells Chris Stokel-Walker what he learned about how to connect better in the digital age



MICHELLE KONDRICH



FEW things in life are as fraught as how we communicate, whether it is anxiously picking the right words to scribble in a Valentine's Day card or agonising over how to ask your boss an awkward question. And that is before you even get into the murkier realm of digital communication and the newfound perils of, shudder, "hybrid meetings".

Andrew Brodsky knows these challenges better than most. Based at the University of Texas at Austin, he is a specialist in workplace technology and communication. His own circumstances meant face-to-face exchanges weren't always possible in his teens, and this led him to study virtual interactions. When the covid-19 pandemic came along and we were all forced onto platforms such as Zoom and Teams, his insights became invaluable.

Brodsky has now studied the virtual communication of more than 100,000 people, and his findings have led to a book, *Ping: The secrets of successful virtual communication*. Leveraging his research and insights from others in the field, Brodsky unlocks the secrets that can help us succeed in our personal lives and careers – as well as giving some pointers on obvious pitfalls. Should that meeting have been an email? How close do you have to be to someone before you send them a voice note? Brodsky has the answers.

Chris Stokel-Walker: Communicating digitally is something we all have to do, but what was it that led you to look at this so closely?
Andrew Brodsky: One of the things that was very impactful in my life is that I'm a cancer and bone marrow transplant survivor. When I was initially in treatment, I spent a good chunk of time having to interact with people virtually because of my immune deficiency, and it made me think: "How can we do this better?"

We're now all virtual communicators. In the office, it used to be that the only way you could talk to someone or ask a question was to go over to their cubicle or desk. Today, even if someone's only 2 feet away, we're sending them an instant message or email so as not to interrupt them. How these technologies impact communication and how we can do it better felt like a really important question that was being lost in the conversation about remote work.

Why is it important that we do this kind of communication well?
Communication is at the core of pretty much every outcome in our work lives, as well as our personal lives. At work, your communication is vital in showing you are engaged in the organisation and it's important for building relationships. Also, a point often missed is that, in the vast majority of jobs, there is no truly objective measure of performance. So much of the way that managers evaluate performance is based on their perceptions – and the filter between your actual work and their perceptions is how you communicate.

It feels like I'm personally bombarded with all kinds of notifications, from app alerts to phone calls and texts. Has our communication got better or worse over time?
There's been a tremendous benefit from using digital channels. We can now communicate much more easily and richly with people all around the world, people we might not have interacted with previously. But the advent of communication technology has only occurred in recent human history. We're all figuring out how to do this the right way, so a lot of things end up going badly.

How do you study digital communication in a scientific way?
It's very multidisciplinary. There are studies in psychology, business, communications, information sciences and other fields. As a result, there's a variety of different methods. There are simple laboratory studies, where you do experiments comparing people communicating through instant messaging versus face-to-face. There are also field studies of people communicating in real-life contexts. Other researchers take a more qualitative approach, conducting interviews to understand preferences. In the book, I bring together my own research and over 100 other studies. My own work ranges from looking at parent-teacher interactions at an international school in Vietnam to an analysis of 48 million video meetings.

You have studied an awful lot of people's communication habits through those various methods. Are there lessons to be learned at a general level?
One of the biggest is that we tend to be very thoughtless when it comes to choosing a mode of communication. Often, people will have weekly hour-long meetings when a single email could have accomplished the same goal of relaying the necessary ›

information. Or in the context of a conversation that started by email, people are unlikely to move that out of email, even in situations when a quick 5-minute clarification phone call could have saved days of back-and-forth due to a misunderstanding.

So how do we pick the right form of communication for a task?
There's a lot of science that helps us understand this, including some predating the wide adoption of the technologies we use today. A key idea that has emerged from these studies is known as task-technology fit. In other words, you first want to figure out what your goal is for the interaction. Is being productive what matters most? Is it about building a stronger relationship? Is it about trying to come up with innovative ideas? Is it that you want to make sure everyone feels included? I would love to say there's one mode that's best. But it's not that simple.

For instance, if you're meeting someone new and you want to show you're engaged in a conversation, having your camera on during video calls is useful. Alternatively, if you've got an existing team, impressions are already built, and your goal is to focus and maintain your energy, so having video cameras off can be more beneficial, because of Zoom fatigue. This last point is something Kristin Shockley at the University of Georgia and her colleagues explored in a 2021 study. They found this video conferencing fatigue can even spill over to undermine an individual's performance in meetings that happen the day after.

When we're interacting in person and someone is standing in front of you, you're acutely aware of the person and you're very focused on how they're going to react. On the other hand, when you're interacting virtually, you're often just staring at text on a computer screen. Even during a video call, you're staring at a small square. As such, it's easy to become overly self-focused, as Talia Ariss at the University of Illinois Urbana-Champaign and her colleagues found in the early days of covid-19. They conducted a study that showed the proportion of time you spend staring at yourself during a video call is associated with a more negative mood following the interaction.

You mentioned that bosses evaluate us based on our communication. Could people apply your insights to communicate better with their boss?
If you're requesting Zoom meetings with your boss twice a day, there's a good chance you're really going to bother them. Research shows generally shorter video meetings are more effective at building relationships. If you're remote, having short video touch points every so often is better than having one very long, less-frequent meeting.

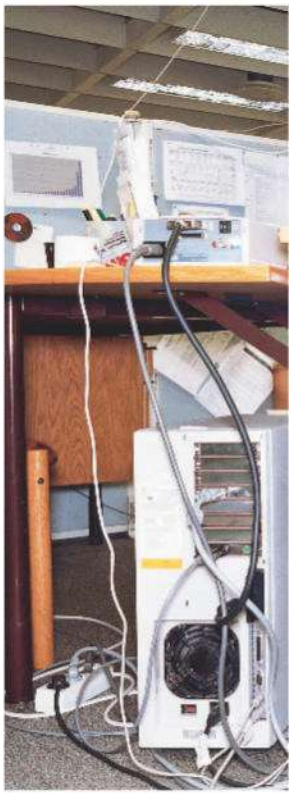
Instant-messaging tools like Slack can also be useful for one-off questions. A boss will think someone who sends a short note summarising their work for that day, every day, is more productive than someone who waits until Friday to recap. But again, you should be careful not to go overboard.

Have all these new means of communication actually hampered our ability to connect with colleagues?
There's mixed research on this. A study from 2001 found "computer-mediated communication" gave people liberty to

"If communicating with someone who uses emojis, use them too. It can make them trust you more"

TIM GOUW/UNSPLASH

Staring at yourself on video calls all day can worsen your mood



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SHINGO TOSHA/AFLO/ALAMY

Anyone with an office job now spends a lot of time communicating digitally

TED HSU/ALAMY

self-disclose more, but then a 2016 meta-analysis comparing face-to-face and tech-mediated disclosure found face-to-face was better – though that only holds for surveys, not experiments.

With some of the least-rich modes of communication, you feel more comfortable disclosing much more personal things about yourself than you would face-to-face, because it almost feels a little bit more anonymous. In those cases, you can build stronger relationships. When you know how to make these communication modes more personal, and how to add back those missing parts of the interaction, then they can often be just as effective – in some cases more so – than in-person communication.

Actually, audio is often overlooked as a good communication option. People often default to either the richest communication form available, like video, or the least rich, like email. Audio is often ignored, but research shows there can be a lot of advantages to it. Compared with email, the telephone comes across as more authentic in terms of your emotion.

One thing that has changed recently at work is the rise of AI assistants. Does that help or hinder our communication?

There are two different parts to this. One is the risk of using artificial intelligence interpersonally. Let's say you write your messages using AI. There's a risk that the other person will realise you're using it. If they think you might have done it once, they start to question every message you sent them in the past.

The other risk is cognitive offloading. A review of research on this topic by Evan Risko, a psychologist at the University of Waterloo in Ontario, Canada, shows that when we have technology do stuff for us – like writing our communications or solving our problems – we don't absorb information from that situation. We tend not to learn anything from it.

That's not to say that AI doesn't have its benefits. It can be really useful for brainstorming, editing, for low-stakes, repetitive conversations. But take a Zoom meeting: if you know an AI is listening in and summarising it, are you fully present in the communication?

I was horrified to learn in the book that we send unintentional signals in our emails...

Lots of information is being relayed and much of it we don't even realise. My research with Hayley Blunden at American University in Washington DC shows people can interpret emotion from something as simple as typos, because typos make your emotions seem more intense. You seem angrier or happier. There are lots of other cues, from punctuation to the time of day the message was sent.

Emojis are also interesting. There's no universal rule about how best to use emojis, but they do become of interest in research related to language mimicry. The idea here is that you should use similar cues as other people, so if they use exclamation marks, use exclamation marks. If they use emojis, use emojis too. The perceived similarity in how you communicate can help to make other people trust you more.

All this has got me thinking about voice notes. It would be rare for me to send a voice note to a work colleague, but perhaps I should?

Part of the reason people can find voice notes annoying is it can be slower to process than text-based communication. It's richer in terms of interactions, which can be useful for building relationships from a productivity standpoint, but it can be more frustrating on the receiving end.

So, again, ask yourself: what is the purpose of the interaction? Is it about showing emotion or something more functional? If you are congratulating a co-worker on a promotion, a voice note might be a really good idea. ▮

Chris Stokel-Walker is a journalist based in the UK covering technology and online culture

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NASA, ESA, CSA, STScI, Janice Lee (STScI), Thomas Williams (Oxford), PHANGS Team

Dear David

Green-eyed monster

Our advice columnist **David Robson** has some scientifically sourced tips for a reader struggling with envy of a friend

David Robson is an award-winning science writer and author of *The Laws of Connection: 13 social strategies that will transform your life*

Further reading

If you are interested in learning other strategies for emotional regulation, I would thoroughly recommend psychologist Ethan Kross's new book *Shift: How to manage your emotions so they don't manage you* (Vermilion)

Dear David appears monthly

Next week

Stargazing at home

IT IS all too human to feel a little jealous of others' success, but what can we do when those feelings threaten to overcome us? One reader this month describes some serious resentment at a friend's promotion: "I just can't help feeling bitter about what they've achieved."

The obvious solution to envy would be to avoid comparing ourselves to the people around us, but that is easier said than done. Humans are social creatures who evolved in hierarchies, and our standing within a group would have had serious consequences for our welfare. As a result, we inevitably use others as a measure of our own success – a habit that can quickly kill any satisfaction we might have gleaned from our own achievements.

We can see this in people's perceptions of their income. Research by Christopher Boyce at the University of Stirling, UK, and his colleagues has shown that the relative ranking of people's earnings, compared with that of others within their social group, is a better predictor of life satisfaction than total take-home pay. Social comparison can also influence perceptions of personal attributes like education or intelligence: it's how we match up to others that shapes how good we feel about ourselves, rather than our standalone performance.

Envy may be exacerbated by a "focusing illusion", which describes our tendency to become fixated on a single facet of someone's life. We imagine that our successful friend is living in a constant state of joy, and forget that they have to face everyday difficulties like an argument with their spouse or the death of a pet.

DAVID LITSCHEL/ALAMY

In one study, Ed O'Brien at the University of Chicago and his colleagues asked participants to imagine a peer with a desirable life. Simply reminding them of the "small annoyances" this person regularly confronted significantly reduced the participants' envy. We can never know what emotional baggage someone may be carrying, and recognising this fact should make us think twice about wishing ourselves in another's shoes, while also urging us to treat them with a bit more kindness.

When we are feeling bitter, we might also reframe another's success as proof that our own ambitions are achievable. To put yourself in this mindset, try remembering all the things within your control to improve your lot, and make a step-by-step plan of how you might achieve that.

Why not involve the person themselves, and ask them about the challenges they faced and how they overcame them? Learning about those difficulties will probably reduce your feelings of resentment and increase your motivation to take positive action.

We may never escape social comparison. When life gives us sour grapes, however, we can choose to make wine from those momentarily bitter fruits. ▮

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Dr Suzana Herculano-Houzel
Associate professor in the departments of psychology and biological sciences, Vanderbilt University.

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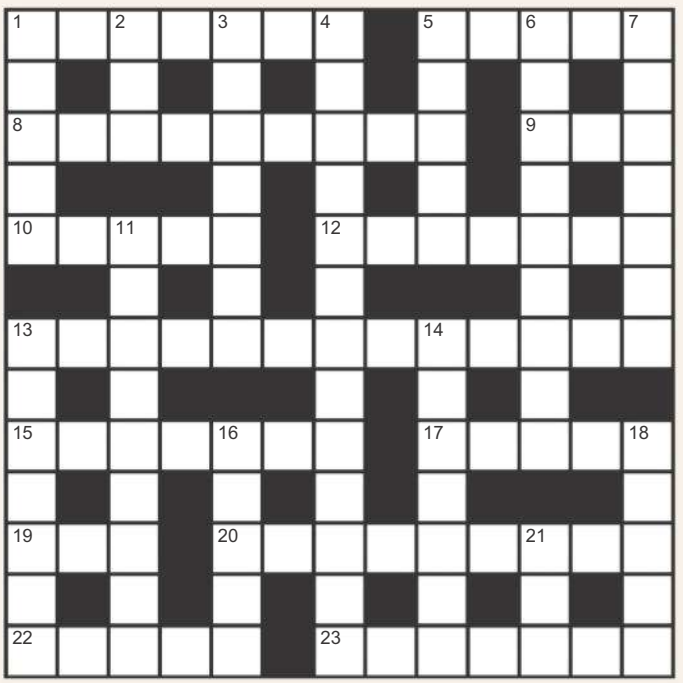
Cryptic crossword #156 *Set by Trurl*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Misspelt caption introduces US car (7)
5 Gold particle, charged by pattern of stars (5)
8 US literary great revealed in May, getting first in English (9)
9 Computer controlled by this broken cup? (3)
10 In trial, give subject one of these (it may cause dizziness) (5)
12 Al initially getting a lot wrong – it's kind of a pain (7)
13 Opposition I'd seen making U-turn in "didn't", "isn't" or "can't"? (13)
15 Small instrument that makes sound like gherkin, quietly? (7)
17 Haughty ass U-turning on article (5)
19 Green for three-sevenths of a second (3)
20 Turn over plot, meeting accessory (4,5)
22 Alpine song for octet in unknown key (5)
23 Green led mare astray (7)

DOWN

1 Insect inhaling gas and rising up? Hogwash! (5)
2 Original 50 per cent of force unit (3)
3 Weller, perhaps, after hip medication in here? (7)
4 Shaken boxer candid on primary cause of climate change (6,7)
5 In Greece, figure from 0 to 10^6 (5)
6 Hard to make out? Cognition's a little scrambled (9)
7 Alternative menu carried by girl for Budapest polymath (7)
11 Kind of coupling covertly dropped, at first, by legendary spy (5,4)
13 Metallic and fuzzy? (7)
14 In probability, Russian leader will exhibit syphilitic symptom (7)
16 Perhaps lights disengaged not quite completely (5)
18 Decomposed metals supported by rigid bottom (5)
21 Elevated position in Turkey range (3)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #291
set by Corryn Wetzel

1 What is the only mammal known to regularly give birth to identical quadruplets?

2 What is the term for fossilised faeces?

3 What is a group of porcupines called?

4 What is the name of the large, dark, basaltic plains on Earth's moon?

5 Who is considered the inventor of the periodic table of elements?

Answers on page 47

BrainTwister
set by Peter Rowlett

#62 Particular patterns in piles

Arrange balls into a row of piles according to these rules:

1. The first and last piles contain one ball.
2. If two neighbouring piles aren't the same size, the change in height is either an increase or decrease of one ball.

There are two valid ways to arrange four balls:

How many ways are there to arrange five balls?

How about six balls?

How many ways are there to arrange nine balls?

Solution next week

Spinning around

Does life require Earth's rate of rotation to lie in a certain range? What are those limits and what changes to life's existence would there be as those limits were approached?

Mike Follows
Sutton Coldfield, West Midlands, UK
If Earth stopped spinning, gravity would remain essentially the same, but the Coriolis effect would cease, causing air to travel in straight lines rather than forming cyclonic systems like hurricanes. The planet would also lose its magnetic field, which protects us from solar wind and coronal mass ejections. As a result, it is likely that we would lose our atmosphere.

If Earth were tidally locked to the sun, one side would be in perpetual daylight and the other in constant darkness, creating extreme temperature differences. The effect of this on life has sparked speculation among science fiction writers – life could potentially exist along the terminator, the boundary between the two sides, but weather patterns and climate would change drastically. The tropical climate zone would be likely to expand, though the planet would be able to support less life.

"If Earth's spin speed rose significantly, hurricanes and cyclonic winds would intensify, with more destruction"

If the planet's spin speed rose significantly, water would be pulled towards the equator, flooding land masses. Hurricanes and cyclonic winds would intensify, with more destruction.

If Earth's spin were 17 times faster (with a period of about 85 minutes), objects at the equator would become weightless and rain would no longer fall there. At this speed, the equator would be moving at about 8 kilometres per second.

If the spin increased further, reaching the escape velocity (around 11 km per second), Earth would complete one full rotation every hour and objects at the equator would be flung into space. At higher latitudes, the speed would need to rise further for objects to become weightless. By then, however, it is likely that the atmosphere would already have escaped into space at the equator, making it irrelevant whether you remained attached to Earth.

When our planet first formed, it completed a revolution once every 6 hours or so. If its rotation continues to slow at the current rate of 1.7 milliseconds per century, its spin period will have doubled to two days by the time it is eventually swallowed as the sun expands to become a red giant in about 5 billion years. So, for truly scary scenarios, you will have to turn to science fiction.

Ron Dippold
San Diego, California, US
First, let us specify that the rate of rotation is relative to our sun. At zero rotation, one side of Earth would always face the sun and have daylight and the backside would be in eternal night. Planets like this exist in other systems, and our moon is tidally locked to Earth, so has zero rotation relative to us.

If Earth's rotation stopped suddenly, the resulting 1670-km-per-hour air and water surges would kill almost everything. But if the change happened slowly enough or if the planet had never rotated, the situation would be surprisingly survivable for life in general.

The average global temperature would stay at around 15°C (59°F), because the solar inputs and outputs would be the same. However, the closest point to the sun would be much hotter and the furthest point much colder. This would drastically change ocean and wind patterns. Winds might be high near the terminator.

On the dark side, you would have a catastrophic loss of plants and then most other things would also die due to a lack of sunlight and food. But we know that some animals, such as deep cave dwellers, survive just fine without sunlight, and there is no reason why plants and many other organisms wouldn't thrive with 24/7 sunlight on the day side. So I would say there is no lower rotation limit on some life existing, then evolving to fill this environment.

With the higher limit, though, there are bigger issues. Currently, any point at the equator is moving at about 1670 km/h. If this were boosted to 28,440 km/h – giving a rotation time of 85 minutes – the spin would counteract gravity. The escape velocity of Earth is 40,270 km/h, so organisms wouldn't be flung off into space. Rather, they would be lifted into the air (very fun at first), then pulled back by gravity and smacked into some ground or water that is now moving, in relative terms, lethally fast. But gravity would have a greater effect the further you got from the equator, as the spin speed would fall as you moved closer to the poles. And I think lice could get used to 85-minute days.

Other things, however, would set an upper limit. Our oceans and atmosphere are only dragged along by friction from the rotation of the planet's surface. At some point, the air and water drag won't

SHUTTERSTOCK/ORESTLYZHECHKA

This sunflower looks as though it needs a good drink. But is it in pain?

This week's new questions

Does it hurt? **Plants wither away when they don't receive enough water and sunlight. Can they also feel pain as a result?** ***Adrian Chong****, Melbourne, Australia*

Thirsty work **Is it more efficient for me to carry water in a bottle or in my stomach?** ***Mick Liubinskas****, Sydney, Australia*

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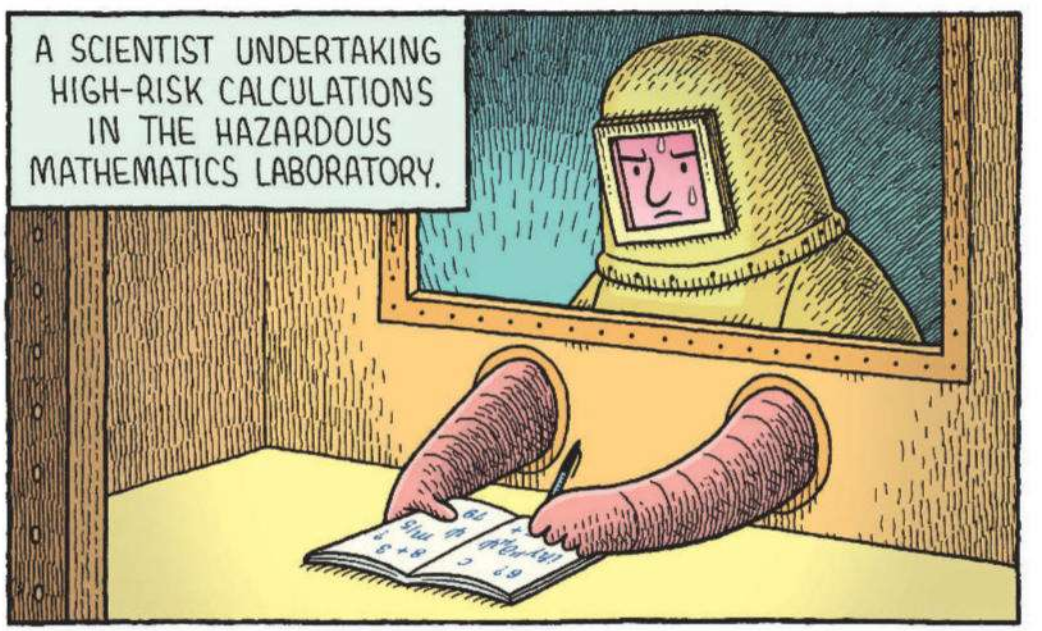
Tom Gauld
for New Scientist



be able to keep up with Earth's increased spin and the surface would be scoured by unending, killing-force winds and tsunamis. This would certainly happen with an 85-minute day, when water at the equator would start to slosh free, but it is also likely to occur even at less extreme spins. Most surface life would die. Yet there would be weaker winds and tsunamis towards the poles, and perhaps bacteria could survive deep inside the planet.

As Earth spins faster, the equator would bulge out further and the pole-to-pole distance would shrink. At some point, the planet would lose its structural integrity. At well below the 85-minute day, gravity would no longer hold down the water or land at the equator. And once the equator goes, the rest crumbles at the edge until you have a much smaller sphere.

There is life deep in the outer crust and perhaps extremophile bacteria exist in the outer mantle just under that, but, as far as we know, there is too much heat and pressure for life lower down.

"In *Surface Tension*, a human ship crash-lands on an Earth-like planet where puddles of water are inhabited by microscopic life"

So I can't tell you exactly where the upper spin limit is, but there is one whenever the rate exceeds Earth's structural integrity.

Life on Mars

Should we be thinking about genetic modifications for the humans that we send to colonise Mars? (continued)

Damir Blazina
Chester, Cheshire, UK
Previous answers to this question mentioned several sci-fi works that are relevant to this topic. I would like to add one more suggestion for interested readers.

In his 1957 collection of short stories, *The Seedling Stars*, US writer James Blish explored the topic of modifying humans to be able to thrive in extraterrestrial environments, coining the term "pantropy" for the process.

Perhaps the best-known story is *Surface Tension*, in which a human colonisation ship crash-lands on a distant planet that is Earth-like, but whose only landmass is covered in shallow puddles of water that are inhabited by microscopic life.

The crew genetically engineer their descendants into tiny, aquatic organisms, who must find a way to survive and interact with the native, intelligent life forms.

In another story, *Watershed*, a spaceship crewed by "original form" humans transports a group of "adapted" humans back to Earth – now a desert wasteland – in an effort to repopulate humanity's home world.

The book received critical acclaim for outstanding storytelling and meticulous attention to detail. Although not directly related to living on Mars, it is still a thought-provoking read that explores what it means to be human. ▮

Answers

Quick quiz #291 *Answers*

1 The nine-banded armadillo
2 Coprolite
3 A prickle
4 Lunar maria
5 Dmitri Mendeleev

Quick Crossword #177 *Answers*

ACROSS 1 Icosiheptagon, **10** Pylon, **11** Ellipsoid, **12** Cannonade, **13** Atoll, **14** Incline, **16** Tintype, **18** Vaccine, **20** Rupture, **22** Drugs, **24** Computing, **26** Rat poison, **27** Indri, **28** Schmidt camera

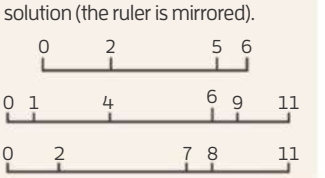
DOWN 2 Colonic, **3** Santorini, **4** Hyena, **5** Polyester, **6** Alpha, **7** Otology, **8** *Space Invaders*, **9** Adélie penguin, **15** Exercised, **17** Neptunium, **19** Caustic, **21** U girder, **23** Storm, **25** Manic

#61 Mark to mark *Solution*

Adding a mark at 5 allows you to measure all possible lengths: 6-5, 2-0, 5-2, 6-2, 5-0, 6-0.

On the ruler marked at 1, for which we can include the ends as points 0 and 11, adding marks at 4 and 9 lets you measure any length but 6 (1-0, 11-9, 4-1, 4-0, 9-4, [not possible], 11-4, 9-1, 9-0, 11-1, 11-0).

Making marks at 2, 7, and 8 lets you measure every length except 10 (8-7, 2-0, 11-8, 11-7, 7-2, 8-2, 7-0, 8-0, 11-2, [not possible], 11-0). Or, marks at 3, 4 and 9 would give the same solution (the ruler is mirrored).



More male than male

In common, we suspect, with most readers, Feedback is casting around for explanations of how the world got into its current position. So we were intrigued by journalist Michael Hobbes's post on the social media site Bluesky, highlighting a 2013 paper in the *American Journal of Sociology* called "Overdoing Gender: A test of the masculine overcompensation thesis".

The hypothesis is that, when men's maleness is threatened, they overcompensate with "extreme demonstrations of masculinity". For example, when men were told they were feminine, they responded by expressing more support for "dominance hierarchies", and said they wanted more personal power. They also became more supportive of war and homophobia.

But the bit that got Hobbes's attention, because it's so utterly ridiculous, is that they expressed interest in buying a sports utility vehicle (SUV).

Reading all this, Feedback was to be found staring into space while the faces of prominent people flashed past. We remembered when singer James Blunt was interviewed on Jessie Ware's podcast *Table Manners*. He admitted that during college days he went on a meat-only diet to prove his manliness and annoy vegan friends – only to be diagnosed with scurvy.

We remembered the many instances of right-wing US men confessing on social media that they did not believe in the existence of the female orgasm because they had never seen a woman experience one.

We remembered Elon Musk and Mark Zuckerberg trash-talking each other over a proposed cage fight for a year. And we thought those sociologists might have a point.

Twisteddoodles *for New Scientist*

Got a story for Feedback?
Send it to feedback@newscientist.com
or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

Ready and not ready

While we are all still trying to adapt to the rise of artificial intelligence, the next technology revolution is on its way: quantum computers. Regular readers will know this already, thanks to issue 3530. But what about all the poor souls that didn't pick that up?

Fortunately, computing giant and Netscape-killer Microsoft has the solution: a Quantum Ready programme, to help business leaders prepare their companies for the coming era.

What is on offer? Why, teaching that will help leaders create "a clear and comprehensive quantum-ready strategy for durable, competitive differentiation". Quantum computing, we are promised, "will soon solve meaningful problems and unlock business value in various areas". Steady with the hype, Microsoft.

As a result of all this coming quantum computing power, leaders must "understand the organizational change required to lead in the quantum era through a structured approach to business transformation aligned with your organization objectives". They should "assess quantum's impact" on their companies, and "execute a quantum application roadmap". In other words: do some research, make a plan and carry it out. Truly, you can't put a monetary value on advice that combines quality and originality to that extent.

Of course, the problem is that we don't know if/when quantum computers will become useful, or exactly what they will be useful for. So a company might spend a lot of time preparing for the quantum future, only to find that a startlingly different quantum future actually occurs.

In a very real sense, even if a company is quantum-ready, it isn't quantum-ready. If only there was a thought experiment that could illustrate such a situation.

How to leave the planet

Given the aforementioned state of things, Feedback occasionally wonders if we might depart planet Earth for pastures new. Admittedly, space travel is fraught with perils like meteorite strikes, intense radiation and the sheer mind-boggling scale of interstellar distances that make your death inevitable long before your craft reaches another star system.

But on the other hand, maybe the grass is greener. In idle moments, we fantasise that the approaching asteroid 2024 YR4 is a disguised flying saucer, and we might be able to cadge a lift to Alpha Centauri.

So you can imagine our surprise when we learned, via sustainability consultant Niki Rust on LinkedIn, of an unusual job posting on Indeed.com. A company called Black Book Resourcing Ltd was seeking a "Pioneer Colonist – Mars Settlement Program". Responsibilities include: "establish and maintain life-support systems", "generate power and manage resources for long-term survival" and (just a little bit of understatement here) "work as a team under extreme conditions".

The rather long "essential requirements" list includes "peak physical and mental endurance" and a "background in engineering, medicine, botany, geology, or survival skills". Confusingly, the list demands both "adaptability and resilience in complete isolation" and "strong teamwork and leadership skills". Finally, you must have "no dependency on Earth's luxuries—only grit and determination". "Prior experience in extreme environments" is optional.

Don't all rush: the listing has expired, and we are not at all sure it was genuine. Besides, given the frankly strenuous requirements, Feedback was stunned to see the proposed salary was just £60,000-£100,000 per year. However, the company deserves credit for listing the job as "permanent" – it most certainly would be. Bonus points for the location, which was described simply as "remote".

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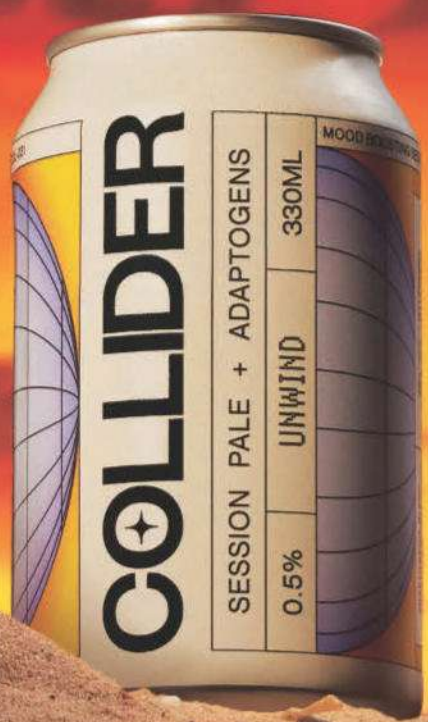

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